JULY 1, 1918 PRICE 15 CENTS

AVIATION AND AERONAUTICAL ENGINEERING

Orville Wright (Left) in Front of a Liberty D.H.4

VOLUME IV
Number 11

SPECIAL FEATURES

THE S. A. E. AERONAUTICAL MEETING

TECHNICAL PAPERS ON AERONAUTICS

THE ORVILLE WRIGHT DINNER

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CONSTRUCTIVE SUGGESTIONS FROM MANUFACTURERS

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Entered as second-class matter, August 3, 1910, at the

HALL-SCOTT

THE year 1918 marks the tenth anniversary of the Hall-Scott Motor Car Company as builders of Airplane Engines.

Ten years ago—in 1908—the first Hall-Scott Aviation Power Plant was designed by E. J. Hall and constructed, following his experience in building motors for his racing car "Comet" This type A-1 four cylinder 40 h p motor was a success, and the entire output, while small, was sold to exhibition flyers

During this early period, the building of aeronautical motors was a money losing, heart-breaking undertaking. But the men behind this company knew that the day was coming when airplanes would be built by the tens of thousands, and they willingly made their investment of time and money in developing and perfecting their Airplane Engines.

By 1912 the Berkeley plant had developed what was then considered enormous production—fifty motors a year. Van M. Griffith writing in the *Los Angeles Times* of the Third International Aviation Meet, said:

"*Of the nineteen machines used in this meet, eight were equipped with Hall-Scott motors, and of the twenty aviators who flew, nearly half used motors of this make. . . . The Hall-Scott motor has made a great name for itself and ranks today as the most popular Aeronautical motor in all America.*"

Sub-Assembly Department

HALL-SCOTT

"War has been the making of aviation," said General William Brancker of the British Royal Air Force. While not responsible for the "making" of the Hall-Scott Engine, the war has made necessary many changes, perfections and increased production.

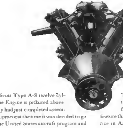
Shortly after the outbreak of the war in 1914, an order for 300 type A-5 125 h. p six cylinder engines was accepted from the Russian Imperial Government. This order was produced under the most rigid government inspection and was completed thirty days ahead of schedule.

In February of 1918, the Hall-Scott plant was working to full capacity and had, at that time, an output of fifteen motors every twenty-four hours.

The following pages tell of two of numerous types of Hall-Scott Airplane Engines and of the official statement of the War Department relative to the successful Liberty Engine.

Testing Department

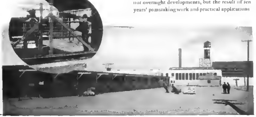
HALL-SCOTT



THE Hall-Scott Type A-8 twelve cylinder Airplane Engine is pictured above. The Company had just completed assembly of this equipment at the time it was decided to go ahead with the United States aircraft program and gave up their idea of production on account of interference with the Liberty 12. This first engine weighed approximately 1100 pounds, but the Company had ready steel cylinders and other parts to reduce the total weight, with built-in electric starter to about 800 pounds, with a figuring of 450 h. p.

The cylinders and many of the parts are interchangable with those of Hall-Scott four, six and eight cylinder engines—a feature that is today admitted to be the best practice in Airplane Engine building.

As evidence of the proven worth of Hall-Scott design and construction, many of the parts in the Liberty Motor were copied from Hall-Scott equipment. On the page following is reproduced the official statement of the War Department as printed in the Congressional Record. Note carefully the credit given the Hall-Scott Motor Car Company and remember that these features were not overnight developments, but the result of ten years' painstaking work and practical applications.



One Battery of Propeller Drive Test Stands

Reproduction of the Congressional Record showing the official recognition given to the Liberty Motor

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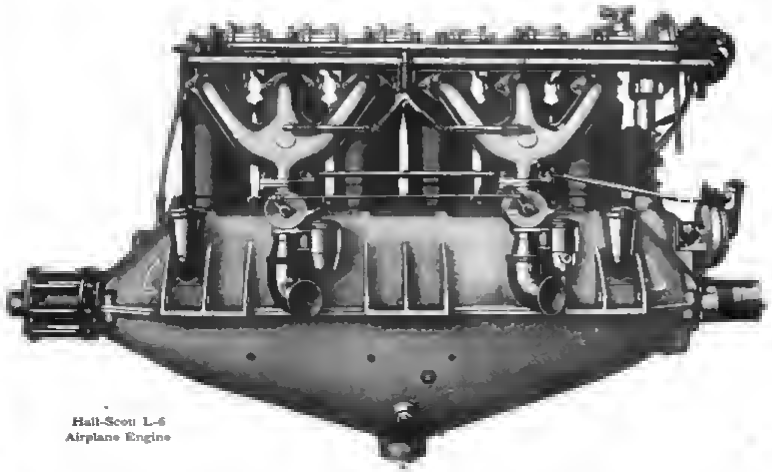

Hall-Scott L-6
Airplane Engine

THE L-6, the latest development of the Hall-Scott Motor Car Company, is pictured above. This motor has been designed by Hall Scott Engineers and produced with a full appreciation that—

A successful automobile motor does not make a successful Airplane Engine and that—

America should and can produce a sturdy, dependable Airplane Engine that would give better service in the hands of American flyers and American mechanics than any of the delicately made equipment of foreign design and construction not adapted to American manufacturing methods.

This type L-6 embodies all of the superior points of the widely known type A-5 and A-5a models, and in addition, the latest features in Airplane Engine practice. This engine has been given thorough running tests under official observation, showing power delivery well in excess of its rated 200 h. p. with a total weight under 500 pounds. Cylinders have a bore of 5 inches and a stroke of 7 inches. Production for one of the Allies has already started.

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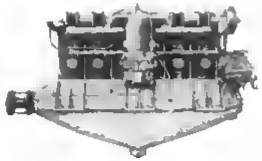

Hall-Scott A-5 Airplane Engine

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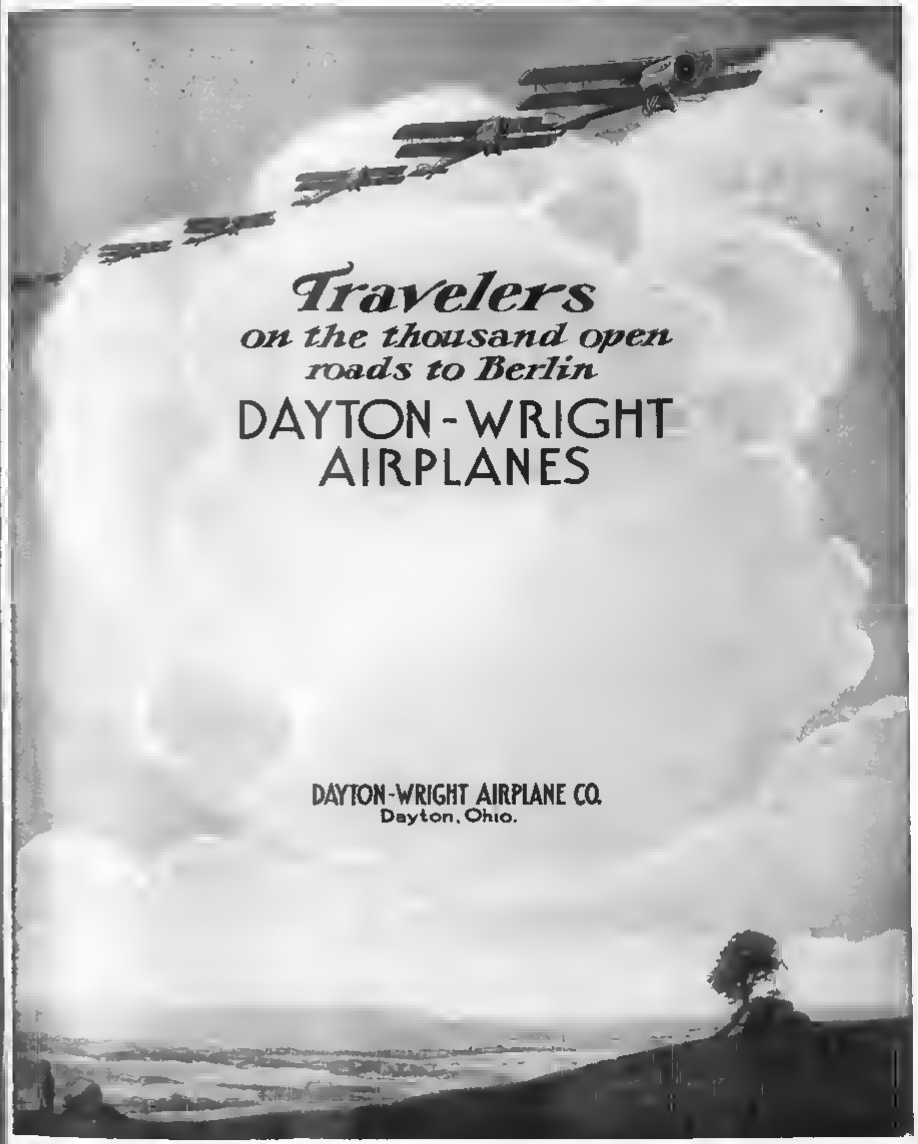
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Many airplane and aviation engine builders have found out by actual experience how superior *Lynite* is to ordinary aluminum—how much more uniform and close-grained the texture of the metal, how much greater the tensile strength.

LYNITE

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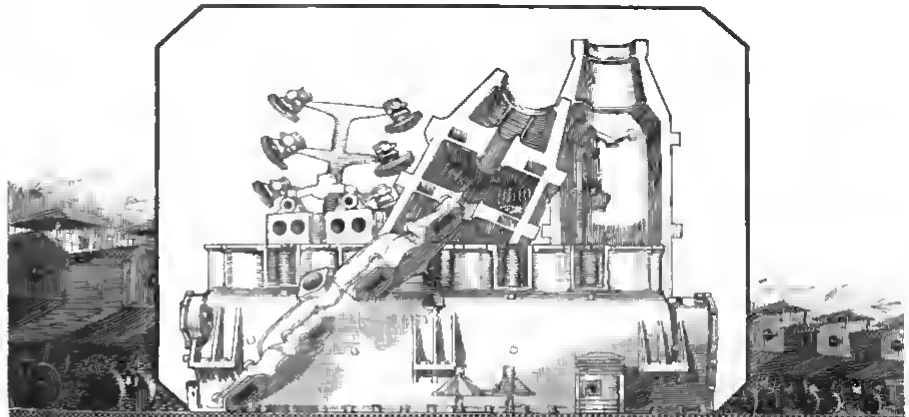

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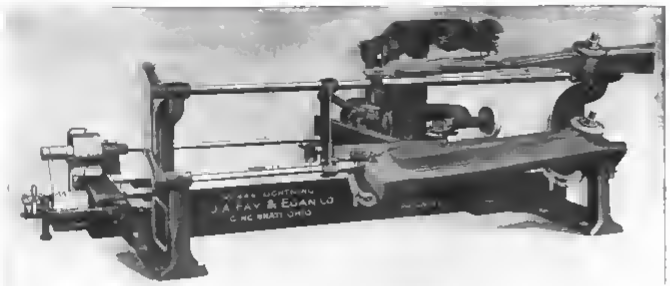

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—England, France and Italy build their great air fleets on these four machines

—why then continue to lose time with experiments and make-shifts when you can have the benefit of over three years' experience in quantity production of every type of aircraft—start where others left off—not where they had to begin in 1914.

—when in April, 1917, our country entered the war, we immediately cabled for the latest ideas that had been developed abroad in machinery for making wood parts for Aircraft.

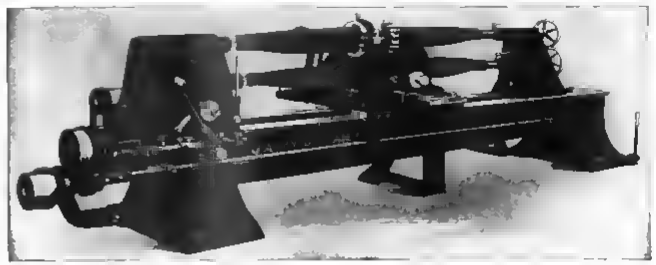
—with the consent of the British Royal Air Board, one of Britain's foremost authorities on this work braved the dangers of the submarines to bring to us complete drawings, models, etc, together with the benefit of his personal knowledge and experience to get the work under way here

No 445 Propeller Vise Stand

—financed entirely by and at heavy cost to ourselves, these first lots of these machines were soon put through our works—and into actual production—our engineers have worked out some improvements to conform to American manufacturing methods—and the perfected machines are now used by the U S Army and Navy, Dayton-Wright, Curtiss, Standard, and other prominent manufacturers in this country.

—as several hundred of these machines have already made good abroad, a large number already making good here at home, and prompt shipments now being available on all four types—why delay production of our much needed planes and propellers by wasting time with experiments and make-shifts that are the product only of inexperience.

—read what these machines will do—and for the sake of our boys "Over There," act quickly



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No. 444—Automatic Propeller Shaper

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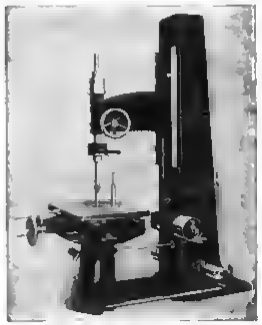
No 446—Propeller Borer



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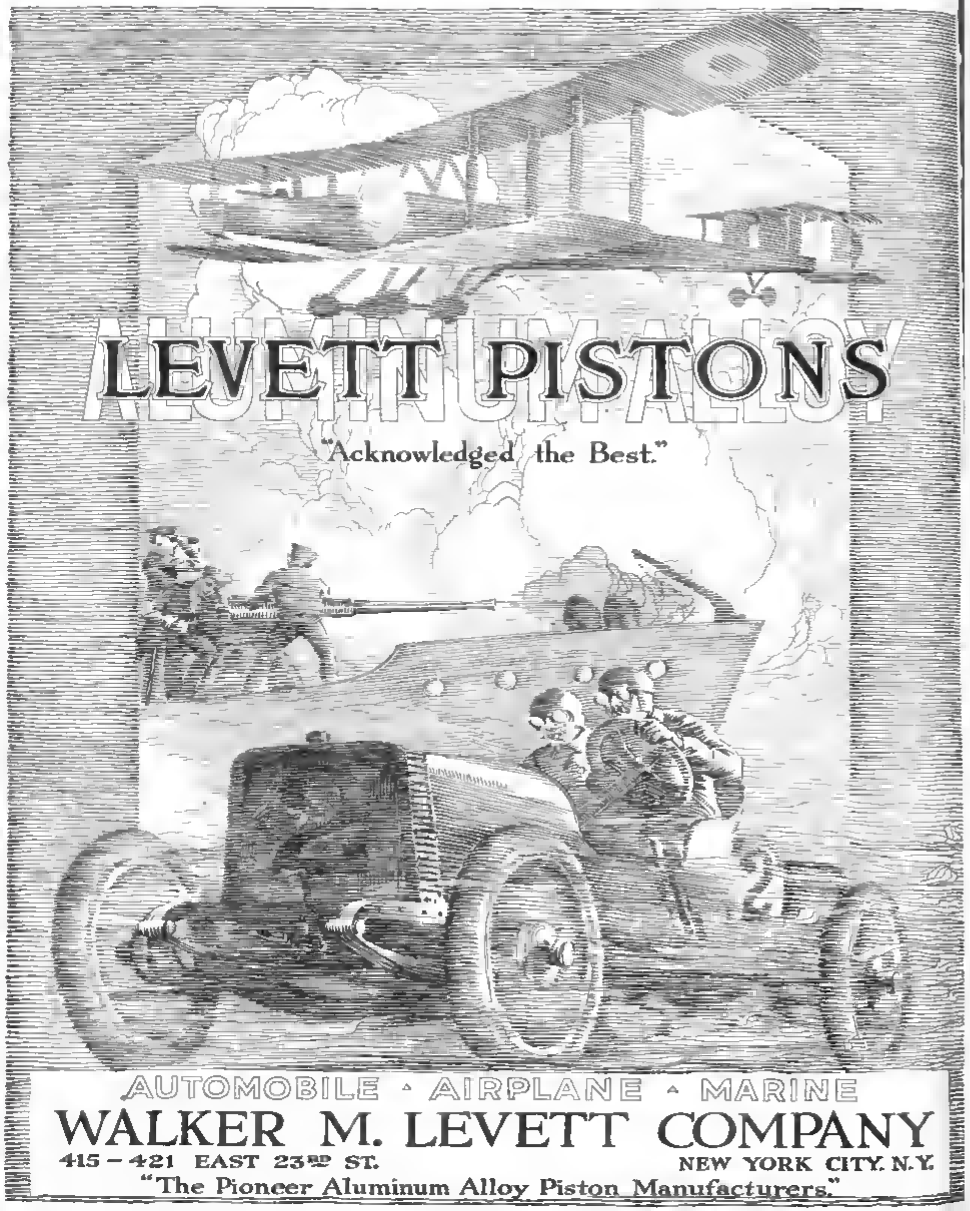
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JULY 1, 1918

AVIATION AND AERONAUTICAL ENGINEERING

VOL. IV. NO 11

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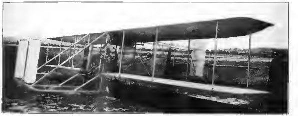
Vol IV July 1, 1918 No 11

The S. A. E. Aeronautical Convention

The annual mid summer convention of the Society of Automotive Engineers, which was held at Dayton, Ohio from June 15 to 18 inclusive, was one of the most notable gatherings in the history of the American aircraft industry. Some 1200 members of the Society attended the convention, which by the nature of its working program and exhibits of automotive apparatus as well as a large attendance of aircraft constructors and aeronautical engineers from the Army, the Navy and the Trade could truly be classed as a representative aeronautical meeting.



ORVILLE WRIGHT AT THE WHEEL OF A MODERNIZED 1912 TYPE WRIGHT BIPLANE

Interesting Exhibits

A large hall at Triangle Park was entirely devoted to an exhibition of airplanes, aero engines, parts and aerial armament, among which the following were particularly worthy of note: a DeHaviland-4 complete with military load and Liberty-12 engine, a DeHaviland-4 body with engine, showing construction, separate DeHaviland wing and control assemblies, showing construction, a Spad single-seater pursuit biplane with Hispano-Suiza engine, a two seater German Rumpler biplane fitted with a 225 hp Benz engine, bombs and two machine guns and a first model Wright machine with its 13 hp engine

The following engines were also exhibited a Liberty-12 dissembled and one assembled weighing 830 lb and credited with 400 hp at 1700 revolutions a 360 hp Rolls-Royce weighing 900 lb and rated at 1800 r p m, a Renault 12 developing 280 hp at 1500 r p m and weighing 805 lb, an eight-cylinder Hispano-Suiza engine weighing 525 lb and rated 200 hp at 2000 r p m, the same engine of the geared down type producing the same horsepower and engine speed and weighing ten pounds less a nine-cylinder LeRhone weighing 294 lb and rated 180 hp at 1200 r p m; a Mercedes six cylinder vertical of 150 hp at 1250 r p m weighing 825 lb, a vertical six-cylinder Benz engine weighing 785 lb and rated at 225 hp at 1400 r p m

During the meeting, three DeHavilands gave interesting exhibitions in stunt flying and executed every conceivable evolution.

Following is a brief summary of the program of the convention

Saturday and Sunday were mainly spent in meetings of the Standards Committee, the S A E Council and a Section Conference

Monday the exhibit of airplanes, aero engines and parts was opened and demonstrations were given of synchronized machine guns firing through air screws, airplane raids on trenches, formation flying, stunting, maneuvers and bombing Five large and fifteen small planes were instrumental in this demonstration and some very fine flying was performed by Aviators Rinehart, Lewis, Doolittle and Freeman, of McCook Field Papers were read the same day by C W Stratton on Petroleum Refining, and by S E Sargent and P L Scott on Heavy Oil Engines for Automotive Purposes In the evening a banquet was given in honor of Orville Wright

On Tuesday further demonstrations of airplanes took place, and papers were read by F W Caldwell on Propeller Design, by W B Stout on Present-Day Problems in Aeronautics, by F L Faurote on Airplanes of Today and by Mr Lewis on Comparison of Aviation Engines Reports were rendered by C M Manly, D H Ehrman and C F Clarkson on the International Aircraft Conference by C M Eason, D F Davies, R O Henderson, Dent Parrett and others on Tractor Development, by Captain Crossley (England) and Captain Vandevelde (France), on Standardization of Transport Vehicles

On Wednesday, the last day of the meeting the members visited several Dayton factories.

Exhaust Headers and Mufflers for Airplane Engines*

By Archibald Black
Chief Engineer, L.W.F. Engineering Co.

In the following notes no attempt has been made to treat exhaustively the design of exhaust headers or mufflers for airplane engines. The paper is intended chiefly to record some data collected on this subject during the past several years.

The exhaust header's primary purpose is to carry exhaust gases away from the engine, but it may be designed to perform certain other functions to advantage. The most important of these is probably the muffling of the sound of the exhaust, which may be brought about by a properly designed header.

In present practice the exhaust is taken care of in several radically different ways, the devices of the different designers ranging from the open port to the elaborate combined header and muffler as now used on some machines.

Typical Constructions

Fig. 1 shows the open port, which was very popular on the

Fig. 1

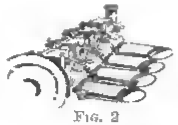


Fig. 2

old engines and was used until recently on the Curtiss 90-hp. JN-4 type engine. In that type no effort was made to carry away the gases or to muffle the noise. Fig. 2 shows the "stub tube" method, used on some Hall Scott installations and recommended by the Hall-Scott Company for its engines. In this system each cylinder is furnished with an individual exhaust pipe several inches long, which points straight out from the engine and is cut off on the outer end at an angle of about 45 deg. to prevent the air from causing a back pressure when the airplane is moving. While this arrangement assists the cooling of the engine, it gives the maximum of noise and would appear therefore not entirely satisfactory for either military or sporting machines.

Fig. 3 illustrates what has come to be known by many as the German system on account of its origin on machines of

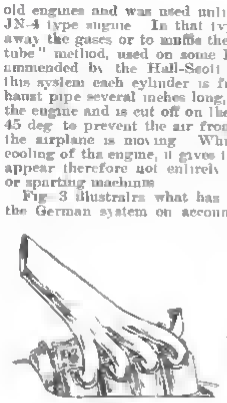


Fig. 3

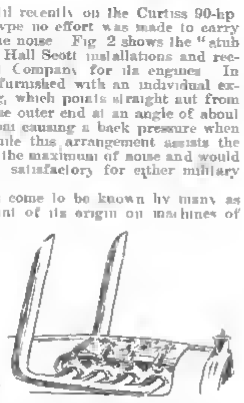


Fig. 4

that nation and apparent popularity among German designers. Tubes extend upward from each cylinder into the common header, which is of stream line section and points upward and slightly to the rear, directing the gases over the top of the upper wing. This reduces the noise heard from below and appears to be a very practicable, although not final, solution of the problem.

Fig. 4 shows an adaptation of the German system used on recent Curtiss JN-4 machines.

Fig. 5 is the original L-W-F header consisting of short tubes run at right angles into a manifold tube, the front end being closed and the rear end connected by a flexible metallic tube to a straight pipe leading along the body to the rear of the pilot, the end being open to permit the escape of the gases. This design was discarded, after the first few machines, in favor of the method illustrated in Fig. 6. Here the individual pipes sweep backward on a liberal radius into the manifold, and the flexible pipe is replaced by a smooth steel tube, which is perfectly straight on some models, depending upon the engine used.

Fig. 7 show the new header and muffler as fitted to some of

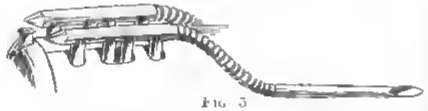


Fig. 5

the Curtiss machines. This header connects to a tube, which extends backward along the body and terminates in a muffler

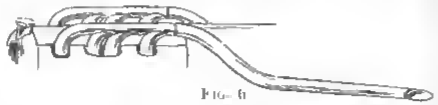


Fig. 6

The muffler is simple and most ingenuously designed; the exhaust tube is slotted and the metal bent outward to form two parallel flanges separated by spacers. The author in the time had no opportunity to examine the earlier of these

Fig. 7

mufflers as installed on R-4 machines, but the following description was reported to him by the field department of the L.W.F. Company. The slot was about 5 to 6 ft. long and about ⅛ in. wide, starting near the engine and running back to the end of the tube, which tapered from the full section of the engine to a comparatively small section, open to the atmosphere, at the rear.

One of the Curtiss engineers stated that no material loss of power was found to be caused by the use of this muffler. It has been generally conceded by those who have heard the engine running with the muffler in place that the noise of the exhaust is reduced to much less than its former volume. This bears out the author's experience with similar devices installed on several engines, these are referred to later in this paper.

At a later date the author made an examination of a similar muffler installed on one of the Curtiss Company's JN machines equipped with Hispano-Suiza engines. This muffler had no large opening in the rear, the slot extending around the end instead. The slot was about 4 ft. long and ⅛ in. wide, approximating an allowance of about 0.04 sq. in. of slot per b.hp.—an extremely small area.

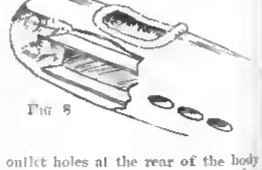


Fig. 8

Fig. 8 shows a method of muffling the exhaust gases devised by Dupré dussin, the French constructor. This is shown as applied to an engine of the rotary type, the gases being carried through internal ducts to outlet holes at the rear of the body.

The French Spad, Fig. 9, is furnished with exhaust headers extending backward for about 6 ft. from the engine. These headers are 3 in. inside diameter and terminate in a muffler consisting of a tube, round at the end, fastened to the exhaust

* Paper read before the S. A. E. Convention.

header, which is flattened toward the rear, where it ends up about ½ in. in height and is considerably wider than the diameter of the front end. This rear end is closed except for four slots similar in those in top and bottom, described below.

In the flattened part, both on top and bottom side, are a number of slots 1 in. long and ½ in. wide, with round ends. Each muffler has 78 such slots, giving a total area of 0.1267

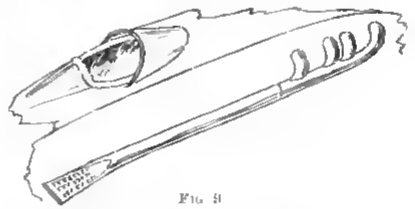


Fig. 9

sq. in. per brake horsepower for two such mufflers, based on 150 b.hp. (the rating of the Hispano-Suiza).

The exhaust pipe allows 0.08836 sq. in. cross-section per b.hp. and has considerable capacity due to its length. This capacity by allowing expansion of gases should assist the action of the muffler considerably. The above figures are exact measurements.

Fig. 10 shows the manifold used on later Mercedes engines. No detailed information on the construction of this manifold has been obtained by the author.

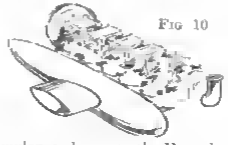


Fig. 10

Fig. 11 illustrates a manifold used on Farman and Breguet machines which appears to be similar in design to the Mercedes referred to above. The author has examined the Breguet manifold, but could not obtain as much detailed information as desired. The inside apparently contains an baffle plates and the pipes from the cylinders enter tangentially to the body. This construction is evidently designed to reduce the velocity of the gases by causing them to expend their energy in eddy currents in the annular chamber.

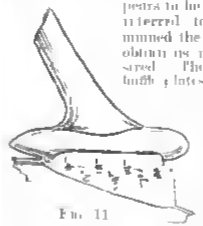


Fig. 11

Fig. 12 is a scale drawing of one of the mufflers tested under direction of Prof. W. T. Fish leigh in the University of Michigan a few years ago. Five mufflers of different designs were experimented with and detail reports were published in *Horseless Age*, May, 1915 issue. Of those tested, the muffler shown here was rated as the best in muffling ability and low back pressure, and one of the two best in low horsepower losses. This muffler was also the lightest of the five. Although the most efficient of those tested, it showed a b.hp. loss of 3.6 per cent with engine delivering 98 b.hp. This device weighed 14.5 lb. and had a capacity of 847 cubic inches.

Fig. 13 is a scale drawing of one of the mufflers tested under the direction of Profs. H. Diederichs and G. B. Upton of Cornell University. Details of the tests are given in the Second Annual Report of the United States Advisory Committee for Aeronautics. The results of tests of the particular muffler shown are given in part in Table I. It will be noted that this muffler caused a loss in horsepower of only 1.5 per cent, from which it would appear that it is efficient enough to justify its application in many cases to airplane engines.

Another type of muffler has been experimented with recently by J. L. Cato of the L-W-F Company. This muffler was somewhat similar to the Spad device, but it had a slot in the end instead of being closed and was provided with small semi-circular louvers in the side instead of slots. The areas allowed and the results obtained were in general very similar to those of the Spad muffler.

Notes on Manifold Design

The two main considerations in the design of exhaust headers and mufflers are the elimination of back pressure and the reduction of noise, which two requirements are, unfortunately, generally incompatible in practice. It is a simple matter to

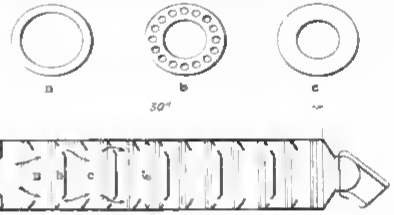


Fig. 12

design headers fulfilling one, but not both conditions. The combining of both calls for a careful study and proportioning of even the smallest features of the device.

Research work of the manufacturers of blowers and air-moving machinery is of considerable help in this work. F. L. Busey conducted a series of experiments* to determine the effects of bends in air ducts. The curves published by him, combined here in Fig. 14, show that, when the radii are small, bends in square pipe offer more resistance than bends of the

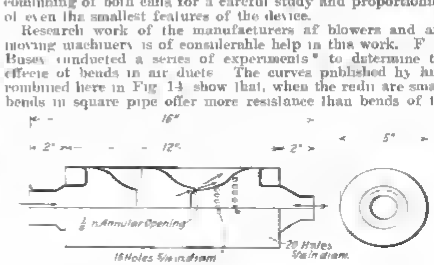


Fig. 13

Table I.—Tests on Mufflers Illustrated in Fig. 13

Brake Horsepower		Horsepower Loss per Cent	Brake Mean Effective Pressure Lbs. per Sq. In.		Brake Mean Effective Pressure Loss Lbs. per Sq. In.	Speed Drop per Cent
Without Muffler	With Muffler		Without Muffler	With Muffler		
60.8	68.6	1.5	87.7	88.8	0.9	0.5

Table II.—Diameter of Exhaust Pipes for 30 to 300 B. H.P.

Based on area 1.0 sq. in. per b.h.p.

Brake Horse-power	Area Required Sq. In.	Diameter to Nearest ⅛ in with No. 20 U. S. Gage Wall		Brake Horse-power	Area Required Sq. In.	Diameter to Nearest ⅛ in with No. 20 U. S. Gage Wall	
		Inside	Outside			Inside	Outside
30	1.1	1⅛	1¼	120	11.9	3⅞	4⅛
40	1.3	1⅛	1¼	130	12.8	4	4⅛
50	1.6	1⅜	1½	140	13.8	4⅛	4⅜
60	1.9	1⅜	1½	150	14.9	4⅛	4⅜
70	2.2	1½	1⅝	160	15.7	4⅜	4⅝
80	2.5	1⅝	1¾	170	16.4	4⅜	4⅝
90	2.8	1⅝	1¾	180	17.3	4⅜	4⅝
100	3.1	1⅝	1¾	190	18.2	4⅜	4⅝
110	3.4	1⅝	1¾	200	19.1	4½	4¾
120	3.7	1¾	1⅞	210	19.9	4½	4¾
130	4.1	1¾	1⅞	220	20.8	4½	4¾
140	4.4	1¾	1⅞	230	21.7	4½	4¾
150	4.7	1¾	1⅞	240	22.6	4½	4¾
160	5.0	1¾	1⅞	250	23.5	4½	4¾
170	5.3	1¾	1⅞	260	24.4	4½	4¾
180	5.7	1¾	1⅞	270	25.3	4½	4¾
190	6.0	1¾	1⅞	280	26.2	4½	4¾
200	6.3	1¾	1⅞	290	27.1	4½	4¾
210	6.6	1¾	1⅞	300	28.0	4½	4¾
220	6.9	1¾	1⅞	310	28.9	4½	4¾
230	7.2	1¾	1⅞	320	29.8	4½	4¾
240	7.5	1¾	1⅞	330	30.7	4½	4¾
250	7.8	1¾	1⅞	340	31.6	4½	4¾
260	8.1	1¾	1⅞	350	32.5	4½	4¾
270	8.4	1¾	1⅞	360	33.4	4½	4¾
280	8.7	1¾	1⅞	370	34.3	4½	4¾
290	9.0	1¾	1⅞	380	35.2	4½	4¾
300	9.3	1¾	1⅞	390	36.1	4½	4¾
310	9.6	1¾	1⅞	400	37.0	4½	4¾
320	9.9	1¾	1⅞	410	37.9	4½	4¾
330	10.2	1¾	1⅞	420	38.8	4½	4¾
340	10.5	1¾	1⅞	430	39.7	4½	4¾
350	10.8	1¾	1⅞	440	40.6	4½	4¾
360	11.1	1¾	1⅞	450	41.5	4½	4¾

Note.—While the allowances given are liberal and based on experience, this table should not be considered final. Additional experiments to determine effects of changing area are always desirable.

* Loss of Pressure Due to Elbows in the Transmission of Air Through Pipes or Flues.—Trans. American Society Heating and Ventilating Engineers, 1913.

same radius in round pipe. The reverse is the case when radii are large. This change of condition takes place when the radii equal about 0.6 times the diameter or side.

The American Blower Company also has made some tests and publishes among its data sheets one giving the resistance of bends in terms of equivalent length of straight pipe.

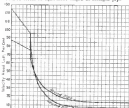


FIG. 14. PRESSURE LOSSES IN PIPE ELBOWS

It will be noted from Fig. 14 that the resistance at the bend is lowest when the radius is equal to $2\frac{1}{2}$ times the diameter, that nothing is gained by making it greater than this, and that this resistance rises to a prohibitive value if the radius is less than 1 to $1\frac{1}{2}$ times the diameter of the pipe. While this curve is based on tests which were made at lower speeds than are probably encountered in an exhaust manifold, Willis H. Carrier[*] concluded, from results of experiments, that losses in elbows through which air is flowing depend on the radius of curvature of the elbow and not on its size or on the velocity of the air.

It would therefore appear safe to assume that the curve given applies equally to the high velocity of flow in an exhaust manifold. Bends of high resistance in manifolds, if near the engine, will sometimes show up by becoming red hot. Sudden changes in the area of the exhaust pipe should be avoided. The areas of the individual exhaust pipes are usually fixed by the necessity of making their ends conform to the ports in the cylinders in order to obtain this condition. When this is not the governing condition, personal experience with different installations of headers and some investigation of the areas of exhaust ports on several successful aircraft engines suggests that 0.14 to 0.16 sq. in. of area per b.hp. of cylinder is a liberal allowance. The exhaust ports of the Hall-Scott A-5-A, Thomas 8, Sturtevant 5A and Liberty, some of the engines studied, averaged 0.1668 sq. in. per b.hp. As large a radius as possible should be used in these tubes which enter the manifold. The latter should be of large sectional area at the outlet end, tapering down to equal the area of the individual pipe at the other end. Where a tube extension is used it should be as straight as possible and of the same sectional area as the manifold end.

The proper area for the large end of the manifold is best determined by experiment with several different sizes, noting the effect upon the horsepower of the engine while running on the dynamometer. This best size will probably vary with different engines, being governed, no doubt, by piston speed and the shape of exhaust ports, as well as by the brake horsepower of the engine. As these experiments, however, cannot always be made, the author recommends allowing about 0.07 sq. in. of area per b.hp., which figure is the average of the several American and foreign installations. When two headers are used, as on eight or twelve-cylinder engines, it should be kept in mind that each header handles only half of the total exhaust. For most engines this allowance will be found to be liberal.

[*] Fan Engineering, 1914 Edition, page 114.

Exhaust headers have been developed by experiment, which have had areas as low as 0.045 sq. in. per b.hp., but it would not seem advisable in the absence of a series of experiments to attempt to reduce the figure given.

In cases where headers are inclined to overheat, it has been suggested that they be furnished with a series of longitudinal fins, welded to the tube, to increase the radiation. Automobile engines have been built which were equipped with headers having fins somewhat similar to these.

Table II gives the required outside diameter of No. 20 U. S. gage tube for various horsepowers, based upon the figure recommended above. This table, while giving satisfactory results, should not be considered final. It would be advisable to remove the manifold and note if there is any change in maximum speed of engine when running without it before the question is considered settled for the particular design.

Notes on Muffler Design

A very interesting and instructive treatise on the principles underlying the design of mufflers is found in part of the previously mentioned report of Profs. H. Diederichs and G. B. Upton.

Another interesting report of experiments, previously referred to, published in *Horseless Age*, contains conclusions from results and discussion of the principles of design.

The chief principle to be kept in mind in designing exhaust mufflers is the slowing down of the exhaust gases until their speed is below that of sound. This is accomplished by regular expansion, surface friction and the changing of the direction of flow. Most mufflers embody all three principles in greater or less degree.

It would appear to be a reasonably safe assumption that mufflers of the type shown in Fig. 13 may be designed for engines of any horsepower by making the areas of pipes and volumes of chambers proportional to the horsepower. The muffler shown is drawn to scale and was tested on an engine of 60 to 70 brake horsepower.

The Curtiss type muffler seems to be one of the simplest and most effective devices in use, and some experiences of the author and his associates with mufflers of this type may be of interest. Experimental mufflers were designed along these lines and were tested on engines of different makes. The noise of the exhaust was, in each case, reduced to very little more than the noise of an automobile truck engine of large power. Tests made with and without the muffler in place showed that no difference in the number of revolutions per minute of engine could be detected with the tachometer while the engine was running at full speed. With the engine running at full speed, one's hand could be held against the muffler slot without discomfort, in contrast to which it was noticeable that the heat of the gases became uncomfortably great when one's hand was held a couple of feet away from the end of the exhaust pipe without the muffler. The speed of the gases was reduced to a slight puff.

Other work prevented the carrying on of further experiments, but the results appeared to suggest that the mufflers which were from four to five feet long could have been reduced in length without loss in speed of engine or muffling effects.

While these mufflers were in use, several things were noted which called for attention. One engine was of the geared down type, and when the muffler was in place the sound of the gears appeared to be of considerable volume, this noise being plainly heard above the sound of the exhaust. As these gears were lubricated by the engine oiling system, it would appear that some reduction of this noise could be obtained were the engine designed to permit lubricating them with a light grease instead of oil. It was also noted, with most of the engines, that once the exhaust was muffled, several other noises became apparent. These included the rattle of valve mechanism and noise of the propeller. In flight, while gliding with the engine running slowly, the "singing" of the wires was naturally more noticeable than before. The engines used in the above tests included a Sturtevant 140 b.hp., Hall-Scott Model A-5-A, Liberty 8 and Liberty 12.

No high degree of accuracy is claimed for the tests described, as they were field and not laboratory tests. The results indicated, however, that in design of mufflers of this type it is advisable that the slot be kept narrow ($\frac{1}{16}$ in. was found to be satisfactory), and that a net area of 0.05 to 0.06 sq. in. per b.hp. is ample. It did not appear to be necessary to leave any opening at the rear end as was done in the Curtiss

R-4 muffler, better results in muffling having been obtained with the smallest end. It is interesting to note that the mufflers now used on the Curtiss JN Hispano-Suiza model have only a small opening in the end.

Materials of Construction

The materials of construction naturally depend upon the type of machine and its size, but for all ordinary work the use of No. 20 U. S. gage for headers and No. 22 U. S. gage for pipes and mufflers will assure parts which will hold up well. For machines of which extreme climbing ability and consequent low weight are demanded, these could be reduced to paper thickness, but it would probably be necessary to renew them often.

Although contrary to general opinion, the author has been informed on good authority, of cases in which the horsepower of an engine with open exhausts has been *increased* by fitting it with a well-designed manifold. This was found in some cases by dynamometer tests and in others by noting the r.p.m. for the two conditions. This effect is, no doubt, due to the gases moving at such high speed that suction is set up in the header, thus giving the effect of exhausting into partial vacuum.

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(a) Report No. 10 in Reports of U. S. Advisory Committee for Aeronautics 1916-17.
(b) Data sheets issued by the American Blower Company.
(c) U. S. Patent No. 1,106,193 to Dopemluaux.
(d) Automobile Muffler Losses Experimentally Determined. *Horseless Age*, May, 1916.
(e) Heat balance Tests of Automobile Engines by Prof. W. T. Fishleigh and W. E. Lay. *Transactions S. A. E.* Part 1, page 82.
(f) *Fan Engineering* (1914 Edition) by Willis H. Carrier.
(g) Loss of Pressure Due to Elbows in Transmission of Air Through Pipes and Ducts, by F. L. Busey. *Trans. Amer. Soc. of Heating and Ventil. Engrs.* 1913.
(h) Flow of Air in Heating and Ventilating Ducts by L. A. Harding. *Trans. American Society Heating and Ventilating Engineers.* 1913.
(i) Coefficient of Friction of Air Flowing in Round Galvanized Air Ducts, by Prof. J. E. Emswiler, *Trans. American Society Heating and Ventilating Engineers.* 1916.

Present Day Problems in Aeronautics*

By Wm. B. Stout
Technical Advisor, Aircraft Board

Airplanes as at present constructed can never become an industrial proposition nor be feasible for commercial work. A radical change in airplane design, if not in theory, will be necessary before air travel, aside from war conditions, can be a commercial success.

WM. B. STOUT

This radical change probably will be the result of rational development, step by step, rather than of any sudden revolution in design.

As related to war conditions—the only angle of approach in which we are now interested—these statements are of equal import, for cost, either of the machine or of its operation after purchase, is but an expression of man hours—the most valuable and important item to be conserved during the war period.

The purpose of this paper is to discuss (a) present day aircraft problems which have bearing in creating the new types of aircraft that must come, and (b) the methods of operation and commercialism that will be necessary in connection with the new types.

After two years experience in war, aircraft have become a deciding factor in combat, and it is becoming more probable every day that the present war will be lost or won in the air.

To win the war in the air there must be sufficient dominance in numbers of planes to over-rule enemy territory and demoralize his fighting units either by direct offensive or by destruction and stopping of supplies and transportation.

Europe can hardly produce under present conditions a sufficient number of planes to entirely meet the situation.

The solution is *America's problem*.

Every engineering problem at its inception presents certain disadvantages and certain advantages. The engineering result in design must of necessity be a compromise to meet the conditions.

No matter what the final design, it will have certain liabilities as well as assets. He is the best engineer who can design the machine, which, as a result of compromise, has the largest percentage of assets with the smallest percentage of liabilities.

Before analyzing the problems and the possible solutions, it is necessary to look at the disadvantages under which America must work as compared with the Allies abroad, so that our final design may best meet all commercial and shipping requirements as well as those of production and technical performance.

In other words, we must first analyze "what to do" before we can determine "how to do it."

In analyzing what to do we must remember that the technical performance of the plane itself is not necessarily the vital factor, but that production capability and strategical performance may in many cases outweigh technical possibilities. It were better, for example, to build planes of 75 per cent performance, and ship them abroad, than to spend time attempting to build 100 per cent planes that we can never hope to build. By all odds, whatever we do, let us *build something*; this has been the spirit with which the American problem has been approached.

In this war it has been possible in some cases to turn engineering disadvantage to strategic advantage. An illustration is the Albatros and other types of planes that Germany has developed.

When the war broke out, the 100 hp. Mercedes engine was practically standardized for German aircraft—and the Hun has constantly adhered to three or four types of engines that he might have quantity even at the expense of quality.

The Mercedes engine as produced was of heavy weight, in comparison with what the Allies were producing shortly after the war was started. It was reliable, however, and the keenly analytical German engineers, being willing to bear with this disadvantage, designed a ship to fit the engine. It was known that the speed of this plane would not be so great as that of the British and French constructions, or would it climb as quickly; it must be able, however, to fight with a chance of success, the swifter, quicker climbing Allied aircraft.

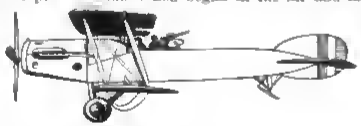
Time was, therefore, spent by Germany in constructing in the Albatros, a plane that can rise to a tremendous ceiling and, once it attains this altitude behind its own lines, cruise out and over beyond the firing line, but within diving distance of home, waiting for the enemy to appear. This machine was so heavy and so well stream-lined that it could lose altitude very rapidly. If an allied plane was unfortunate enough to find itself beneath an Albatros there was small chance of safety in making for home, for the Albatros could dive onto the Allied plane much faster than the latter could dive away even with its engine to assist, so that although technically an inferior plane, strategically the Albatros was for a considerable period no mean antagonist.

Nor was this the only strategy in the Albatros design. The body was built up of thin wood sections nailed together on laminated wood bulkheads—a sort of compromise between boat construction and that of the usual airplane body. The struts between the wings were of steel tubing, the spars of

* Paper read before the S. A. E. Convention.

box sections made of small pieces laminated together.

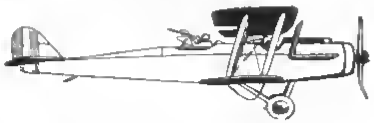
The whole design, while wonderfully trim and, made, one might say, from "cigar boxes and broom sticks," was as nearly a production job as had yet been devised in wood. With this plane Germany had begun in the air and has kept



THE BRISTOL FIGHTER, 1917

strategy and tactics a major part of design ever since. This example shows the thoroughness with which the Germans have taken the disadvantages which they had had to overcome and have made them an advantage by the way in which they have applied the design.

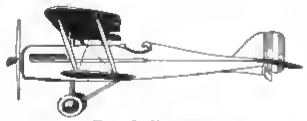
America, like Germany, has certain definite and decided disadvantages that must be overcome in its aerial war program—but disadvantages by the application of American in-



THE DE HAVILAND 4, 1917

genuity may even turn to eventual advantage. These disadvantages may be listed as follows:

(1) Lack of airplane manufacturing experience.
(2) Distance from center of operation.
(3) Lack of knowledge of production methods necessary for foreign designs.
(4) Lack of shipping space.
(5) Lack of equipment and organization for testing and research.
(6) Lack of definite knowledge of strategic requirements along the Front.



THE S. E. 5, 1917

Against these may be set certain advantages which America now possesses and which we must recognize and put to use just as surely as we must overcome the disadvantages. These advantages may be listed as follows:

(1) Knowledge of quantity production.
(2) Knowledge of value of standardization.
(3) Mass of available data (not being put to use).
(4) *Natural creativeness.*

The solution of the problem by use of these assets is our immediate task. In attacking these items and setting the disadvantages against the advantages to obtain a maximum result, we must remember that time is the factor of greatest importance. We cannot take the time, even now, to learn how to design new airplanes for use on the battle front six months or even a year from now. Our present problem is to take what we have and from it get the greatest possible and most immediate result. This will not mean 100 per cent planes or 90 per cent planes, even if they be only 75 per cent planes in comparative performance, they can be of equal use to 80 or 90 per cent planes, provided they can be had in sufficient quantity.

The one and only *obvious* combination of these advantages and disadvantages is *quantity production* of types of planes already in existence in the United States, and of known performance.

Taking the known principles of aerodynamics and performance of planes we now have and developing production constructions—parts that can be produced in thousands a day, tied up into bundles and shipped abroad for assembly over there—thus we can solve, not only our immediate troubles, but lay a foundation for future perfection.

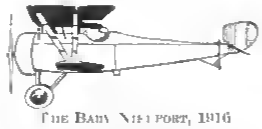
In developing these types of construction—which of necessity probably will be of metal on account of interchangeability—we can at once use that type of American labor found in our automobile plants in producing planes, and thus overcome another present disadvantage.

For 20,000 airplanes, 2,400,000 ribs will be required. If of the usual wood construction, this means that nearly a hundred million pieces must be formed, glued, nailed and screwed

THE SPAD, 1917

together, to say nothing of the inspection and other routine work necessary.

This item alone visualizes what I mean by developing quantity construction, for if we could develop a metal rib stamped out in hundreds an hour to conform to the same aerodynamics and weight requirements as does the wood rib, we would immediately eliminate the necessity for thousands of workmen of the "violin-maker" type who might be put to the construction of other parts and thus add to the quantity possibility.



THE BABY NIEUPORT, 1916

The more items of airplane construction that we can change from the present hand-made "violin" type of workmanship to designs that are fit for quantity output methods, as we know them, the sooner will we complete the program which we now desire.

It is more than probable that we can place a maximum performance type of plane on the battle front more quickly by taking a design and developing it in this production way than by continuously changing from type to type every few weeks, as has been done abroad.

THE ALBATROS III, 1917

In attacking any problem for action and for real results three steps always are necessary.

First, one must know *what to do.*

Second, he must find out by research and analysis *how to do it.*

Third, by organization and executive control, he must *do it.*

No one of these three divisions can be left out and still get really efficient action.

When the war started, America—owing to the patent situation—had small knowledge of aircraft aircraft design, or aircraft manufacture. The firms operating were few and of small talent. To enter the airplane business at that time was merely to invest in a law suit.

Europe having been at war for some time had developed fighting aircraft, regardless of hindrances, and had seen to a certain amount of strategic possibility. In the time available, there was no opportunity for us in America to learn,

more than in a perfunctory manner, just what it was we had to do. The nation and some of its patriots were confronted with the problem of handling all three divisions of action at once, being actually organized and *doing* the job at the same time that they were learning *what they had to do,* and further getting their first education as to *how to do it.*

With all this in view and the confession of a colossal ignorance, not of *anybody* but of *everybody* in America so far as aircraft were concerned, it is a great credit to those who finished the first stage of aircraft production for war that they could do so tremendous a job in so short a time.

When one remembers that within one year a mushroom organization was confronted with the task of spending judiciously more money than was spent on the Panama Canal in eight years, one has a vision of what a real man's job this was.

When one adds to this, the tremendous inefficiency forced upon the organization by just congressional acts, which bound every movement with red tape and suspicion, he sees the task three times as hard to accomplish as though the work could have been done under industrial methods of centralized trusted authority.

That in date in the aircraft program we have accomplished almost the impossible does not by any means prove that our problem is solved. We have spent the time to date learning what aircraft are and how they are being built in Europe. We have had little if any, time to absorb the necessary lessons relating to production and shipping requirements, which, as we have them, are different from those of our Allies abroad.

With the present type of airplane construction an attempt to copy foreign designs requiring foreign types of labor—we may never be the help to the Allies in the air that we wish to be. If America is to produce the cloud of ships which she has promised herself to put into the air, other means must be designed for building aircraft than those now existing.

Aircraft design may be divided into four major branches:

First, *aerodynamics* or the air theory of the plane.

Second, *structure,* which has to do with the materials and strengths of the different parts.

Third, *mechanical arrangement* which is coupled very closely with both.

Fourth, *production design.*

A fifth, known as *accessory design,* might be added.

Aerodynamics, in its fundamentals, is very simple. There is no final necessity for complicated mathematics in working out airplane problems.

Aircraft must be designed for specific uses. If one is going to build a boat, the designer decides how fast he wants it to go, and how much load it must carry. Immediately he finds that a compromise is necessary, for if he builds a hull to give maximum lift or cargo capacity within its dimensions, he has lost speed possibilities and has produced a slow-going craft. On the other hand, if he designs for speed, there comes immediately the problem of reducing the weight of all parts, fuel and cargo, in order to get sufficient flotation within the dimensions that are required for speed.

The same analogy holds in present day aircraft, and the wing curve of a plane is a fairly decent analogy to the boat. A deeply cambered or curved wing, of fairly thick section, gives great lift at steep angles, and is ideal for weight carrying. This type of wing curve is shown above in Fig. 1. If, however, one designs for speed, he selects a wing better streamlined and which disturbs the air less at flat angles.

Remember that at speed the pressure on the wing becomes greater per unit of surface area, and as the pressure becomes greater, the plane flies with a smaller angle of incidence.

Thus, when the heavy lift wing, shown in Fig. 1, gets up great speed, it takes a smaller angle and offers at once a great deal of resistance to forward travel through the air. To try to make a wing of this curve travel at speed is just as sensible, as I have said before, as to attempt to crowd power into a canal boat and turn it into a racing yacht. The addition of power will do nothing but pile up a bigger wave in front of the ship and will add almost nothing to its speed.

This has been proved in certain types of planes, we have replaced 400-hp. engines by engines of 200 hp., but as a result of double the thrust, the gain in speed was only 3 or 4 miles per hour. As a contrast to this, we have taken the same engine in a much heavier plane, but fitted with a speed

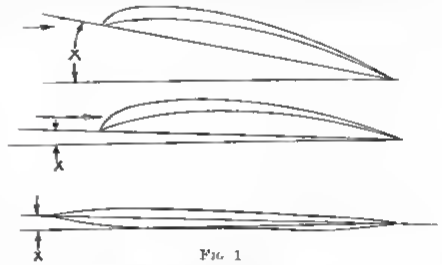


FIG. 1

wing curve, and have driven it at tremendous speeds.

This brings up one of the earliest ideas which was used to design planes for speed, and which was mentioned before the Society last year by one of the speakers* from abroad.

Although the heavy-lift type of wing can not be driven to speed by the addition of power, yet the speed type of wing can be driven to greater lift by one or two methods, first by increasing the flying speed, which means landing speed, and second by adding greater area to make up for the loss per square foot of lift.

Racing planes, rather than having clipped wings of heavy lift, tend toward large wing areas and light loading, but with the merely stream-lined wing curves shown in Fig. 1.

In adding this wing area one must also add more wing area to lift the weight of the wing area he has just added, which is the equivalent almost of a dog chasing his tail. The additional weight per square foot in the wing is around three-

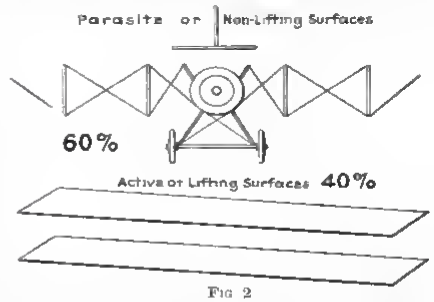


FIG. 2

quarters of a pound, yet, on account of the extra weight of this new wing surface also, one must figure a weight of 1½ lb. per sq. ft. for all the wing surface added.

Addition of weight on the wings, however, is not of much tremendous importance if one does not increase the flat-plate or parasite resistance, a point that I will explain later.

If the designer increases the weight, however, of the engine or body he must add 3 pounds to his total for every 1 pound of additional engine weight; either in extra wing structure, extra tank weight or fuel weight, or added truss. These figures are, of course, structural figures, but I give them to show how closely structural, all the way through, are connected with the aerodynamic considerations, and that in changing the aerodynamic features, one cannot for a moment forget the structural fundamentals that he must follow.

By developing the idea of increased wing surfaces and greater penetration of speed possibility on the part of the wing curve, we have been able to build airplanes of such wing efficiency that the wings have now become one of the least

* Wing Comdr. J. W. Seddon, R. N. A. S. Design and Production of Aircraft in Time of War. S. A. E. Transactions, Vol. 12 Part II.

points of resistance at high speed, for the parasite resistance is dominant.

Fig. 2 shows the so-called parasite parts of the airplane. These are the parts necessary for structural or operating reasons, but which offer resistance to forward travel without adding to the lift or support of the plane. They include struts, wires, landing gear, radiator, piping, exposed control wires, pulleys, body, tail surface edges, tail skid, and things which to the layman seem so trivial as to warrant no real thought. In a speed plane, however, the exposing of a water pipe from the engine to the top wing, might slow down the maximum speed of the plane 5 miles per hour. Adding stream line wires in the place of round cables might add 10 miles an hour to the speed of the machine.

In speed planes today, at maximum rate of travel, more than 60 per cent of the engine power and gasoline consumed is used up in forcing these parasites through the air, and only 40 per cent of the horsepower is usefully used. It is as though a speed boat going through the water, and having a beautifully stream lined hull, should be forced to run a race with a log dragging behind, or like a car in a race with the emergency brake set the whole time, wasting power for nothing.

The greatest problem today of the aeronautical engineer, both as to aerodynamics and structure, lies in the elimination of the parasite, or as the British call it, "flat plate" resistance.

While the airplane today contains essentially the same units of structure as in the beginning, yet the mechanical arrangement has varied as new engines, materials and processes and greater experience in flying have shown the way. The early two-propeller pusher with exposed pilot and no body construction gave way to the single-propeller pusher type with the pilot seated in front of the engine. In case of a spill however, or a bad landing, the engine had a nasty habit of coming forward through the pilot before striking the ground, for which reason particularly this type of machine was gradually discarded. Another deficiency of this arrangement was that in case of propeller breaking, which happened on the small-engined machines of the early days, the pieces of the blade were likely to cut off the rear tail structure and bring the pilot to serious grief.

Then came the tractor type of plane first shown in the Nieuport monoplane with the engine and propeller in front and the pilot just back of the wings. This type of plane has passed through a high state of development in all sizes within the horsepower limitations of one engine.

With the next new mechanical arrangement first principles were used, two propellers being placed out on the wings and *pushing* the planes. The engines were directly connected to the propellers, and were fitted on the wing. This later gave way to a similar arrangement of the engines, but with *tractor* propellers in front of the wings. Recently we have had planes fitted with many engines distributed over the wings, each with a separate propeller. Some of these machines weigh as much as fifteen tons.

Outside of engine and propeller location there are three general mechanical arrangements of these tractor planes: monoplanes, biplanes, and triplanes. These types are so well known as to need no further description. The monoplane aerodynamically is the best type of design but constructionally it is to date almost impossible. Requiring double the area in one wing for the propelling of the same spread of wing, the monoplane must either have a wider spread or a deeper chord. This decreases the aspect ratio and hence the aerodynamic efficiency. To increase the span of the machine means structural difficulty, as the spars can only be as thick as the wing section will allow and beyond a certain span this construction cannot be built with the factor of safety required in the air. Efficient monoplanes, therefore are ordinarily flimsy and dangerous for quick evolution having less space and heavier wing loading than the biplane on account of structural limitations. As a result, they have a considerably higher landing speed, which again makes them dangerous except for the most skillful pilots.

A big disadvantage of monoplanes in war is the tremendous blind spot under the wings, where the pilot can see absolutely nothing. He can see everything above and out to the horizon, but nothing below him. The parasol monoplane developed with the wing above the fuselage so that the pilot can see beneath and above, gives excellent vision but compromises with center of thrust and head resistance in such manner that it is still of doubtful value.

Structurally the biplane is superior and is far less in weight per square foot but again there is a difficulty of vision. Although the pilot can see more below, since he is further up from the lower wing and has a narrower wing chord to hide his view, he has a second wing above him which slightly hinders his view, enabling a plane to dive on him from the front along a certain line without its being seen until it is close at hand.

Every blind spot on a machine is dangerous, especially in bombing machines or combat types, because the Hun pilot spying a machine from afar and "seeing you first," knows from the make of the machine just where the blind spot is and how he can sneak up under it or around to one side in such a position that he cannot be seen until he opens fire. In formation work one is not permitted to circle around in order to retain his vision in all directions. Over enemy territory, it is important that the pilot keep his place in the formation, traveling and reducing speed with it.

A man in a formation over enemy territory who misses his place in the line and for any reason falls behind is much like a ship which in a convoy crossing the Atlantic has engine trouble and falls away from the protection of the battleships and destroyers. One never knows when a speed scout flyer is hiding in a cloud. The Huns follow a formation fleet across-country as submarines follow a convoy, and pounce at once upon any plane that drops behind to an unprotected position. If one flyer on the fringe of the formation may by attack be forced to dive away from his fellows, he is immediately at the mercy of the Hun scouts who will not come too close for fear of receiving the combined machine gun fire of the squadron. If there is a blind spot in the machine, it is possible to force it out of formation.

To permit better vision and also in an attempt to decrease head resistance by the elimination of struts, the triplane has been used extensively. In this type the wing span can be fairly narrow enabling the machine to land in confined places. The wings are so narrow that the pilot's view is almost complete, while the tail construction is small and short allowing greater agility for air fights and less chance of the enemy flyer hiding where he cannot be seen.

There is no division as yet as to which is the best type, but in analyzing present-day problems one can suggest the following lines of experiment with each type of machine:

1. How can we overcome the visional and structural disadvantages of the monoplane in order to acquire the aerodynamic advantage which we must admit the bird type of plane possesses?

2. How can we develop the biplane for less parasite resistance and greater vision—although this type is today in a higher state of development than any other?

3. How can we obtain greater aerodynamic ability of the triplane to fit the decided structural advantages which it possesses?

We may thus run the gamut of experimentation from aerodynamics to structure and back again in these three types of planes alone. And there are others unthought of.

Following the discussion of present possibilities and requirements in airplanes for war and of the next steps to fit what we know to the requirements of today, it is worth while to look ahead to see what the future offers in the eventual development of aircraft.

In the development of the automobile not one-hundredth of the money per month was spent in perfecting models and ideas that is now being spent on airplanes. New automobile models were brought out annually and were in the experimental stage for months.

New airplane models must also go through these months of experimental work, but on an average new models and types are taking precedent on the battle front every eleven weeks.

The automobile industry has developed materials and processes, parts and types of organizations through years of effort. In developing aircraft we have all of these related industries and organizations to draw on for knowledge and material. We are thus able to move in development work *five times as fast* as was possible with the automobile—a fact which is worth more than passing thought. This means that the man entering the aircraft industry today *must think five times as fast* as the automobile executive, in order to keep

up with the industry, and that an engineer must have five times as much vision and mobility of mind in order that he may keep his place in progress.

A very fine line must be drawn between conservatism, as we have known it in other industries, and what we call conservatism in the aircraft industry. What would be reckless judgment in established industries might well be ultra-conservative judgment as related to aircraft design. It is largely for this reason that during the war period the business man of the old type has been so quickly eliminated from this new industry in favor of that type of man who thinks quickly and fast, and is willing to take long risks, trusting to his own judgment. This type of action necessitates great mistakes as well as great successes.

The British Air Board, for example, was changed five times in the first year of its existence, largely, we are told, because the industry grew faster than the vision of the men then in the Air Board could follow. This work is now entirely in the hands of one man, and a man of quick acting vision and definite commercial experience. That our own program is taking similar form, so far as organization goes, is one of the most encouraging items of today.

This type of vision naturally requires that research follow every available idea, and research is but a way of "wasting money intelligently." Tremendous sums can well be spent during the next few years in developing aircraft for war, remembering that a day of war saved means a gain of fifty millions of dollars and six thousand lives.

With these ideas in mind it would be well to conclude this analysis with visions fanciful as we can summon to mind, which still are based on sound engineering judgment. From this viewpoint I predict that operating speeds will exceed five miles a minute in airplanes before we can call aircraft really developed machines.

I have discussed the parasite or flatplate resistance as being a fundamental defect of aircraft. Fig. 1 shows the parts that at high speeds now form the greater part of such a loss.

The solid area in the curve, Fig. 3, shows approximately maximum performance to date. The ordinates indicate the horsepower required, the abscissas designate the miles-per-hour of speed. It is evident from this that above a certain point additional horsepower does not give an equivalent addition in speed, so that even should we double the horsepower of engines of the same weight we would not materially increase the flying speed of a plane as built today, although we could reduce its landing speed.

It is possible to operate wing sections efficiently at a speed of 8 *miles per minute*, as is proved by propeller tips on machines flying at present. These tips in our Liberty planes travel 8 miles per minute, and their efficiency is nearly 85 per cent. There is no reason, from a pure engineering standpoint, why curves in the form of wings cannot perform equally well. The fundamental difficulty is in landing, for although it should be possible to build a machine today to fly at almost any speed we want, yet the landing problem is so great as to make real speed prohibitive.

If we learn from the German long distance gun, which sends its shell up from the earth to a point where the atmospheric resistance is negligible, we may also send airplanes to equivalent altitudes, with special engines developed for that work, and thus in a much lighter medium, with less resistance, obtain our speed range. This will require the solving of many problems. It will mean new propelling apparatus, or propellers. It may even mean special fuels to be used at altitude.

There are various ways of attempting the problem and as we are gaining experience through actual work at 20,000 feet and over it is possible and even, in my opinion, probable that long distance travel in the future will take place at altitudes more than five miles above the earth's surface. It is as though a ship on the ocean could pick out for itself water of varying density, so that for speed work it would take a medium of less resistance, or to use another analogy—it is like the seaplane, which when its operator really wants to travel fast rises from the water and ascends into a lighter medium, even though this lighter medium requires greater supporting area. In altitude work, however, this necessity for greater area will be compensated by the greater speed, which is the fundamental desire.

And so we come to the problem of landing. As soon as we have a plane that we can force to travel at high speed (see the dotted possibility line in Fig. 3) landing will become a dominant problem. We ordinarily visualize safety in landing as depending on speed alone, but speed is only one of the elements of safety. That real safety may be had *three* things are necessary:

1. To land within the smallest possible area.
2. To land on the roughest possible ground.
3. To touch the ground at the slowest possible speed.

Eventually airplanes will land almost in their own tracks,

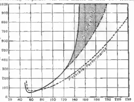


FIG. 3

much as a pigeon lands on a window sill or a sparrow on a wire.

It is by no means proved that our present method of landing airplanes is the final one, and intensive study should be put on the development of new landing systems and schemes, that greater things may be accomplished.

In analyzing landing and any one factor concerned with it, the other fundamentals should be kept in mind. Modern speed planes, for example, landing at 50 m.p.h., need a large field in which to alight, on account of the angle at which they come down and the distance they roll after striking the ground. The airplanes used in the early exhibition work flew from and landed in ball parks and four acre lots, in comparative safety. Present-day machines cannot do this on account of the necessity for speed.

Here is a thing that we know can be done, and efforts should be made to increase the landing capabilities and safety of existing planes. All three landing fundamentals require separate study.

Speed in landing is largely a question of wings and their loading per square foot. A plane with a heavy wing loading lands at a higher speed than one with light wing loading. A plane that leaves the ground at low speed generally is hindered in its high-speed flight, and an airplane is too fast to fly only when it lands at a speed that is too great to be safe. Once in the air, flying at a high speed is not a problem but an advantage.

If landing speed can safely be increased to higher limits, then the maximum speed of the plane can be increased in proportion.

Planes with surfaces that are small for their weight glide at a steep angle and come down fast. After they have touched the ground, however, their air resistance quickly stops them.

Planes with light wing loading "float" very easily, coming down to their landing place at a very flat angle. They must travel a considerable distance over the trees before touching the ground and, although they touch the ground at comparatively low speed, they roll a long distance before coming to a stop.

Not long ago I was interested in seeing a landing made by a pilot who had a plane of the "floating" type for the first time, and who was unused to a machine of light wing loading. He made a beautiful landing in the center of the field, though at a higher speed than the plane was designed to land at, although at the landing speed he had been

accustomed to in other planes. Once on the field, however, he had acquired so much momentum that the plane went on and on, across the field until it struck the fence on the far side.

Fig 4 compares the landings of the slow-speed and high speed types of planes, it being seen that the high-speed plane, although it strikes the ground faster and at a steeper angle, comes to stop more quickly and can land in a smaller place.

A machine of light wing loading, coming into the field over the trees as shown, must float a long distance at a flat angle before it strikes the ground. If the pilot nose the machine down sharply over the trees, by the time he has lost sufficient

Fig 4

altitude to flatten out he finds himself making a high-speed landing, so that the fact that his machine can land at slow speed has done him no good. After he strikes the ground as just explained, he runs a tremendous distance, and is in great danger of breaking the machine, although with small danger to himself on account of the comparatively slow speed.

The problem then is not entirely one of landing speed. No matter what speed the plane lands at, within reason, if the wheels strike no obstruction, the landing is a safe one. However, at high speed they strike a hole, or a ditch, or a rut, there is a tendency for the machine to nose over, or even turn a somersault, to the great danger of its occupant. This danger is, of course, less at a lower speed. In other words, in an emergency landing with a high-speed landing machine there is really less danger of running into objects bordering the field. There is danger, however, of nosing over, if the field is bumpy.

With a machine landing at high speed one can see that having the weight close to the ground would be a considerable advantage, a point that has been discussed somewhat in connection with mechanical arrangements. This indicates a requirement in engine design that has been lost sight of during the early development period when engineers have been learning the fundamentals of aircraft design. This requirement is that the center of thrust due to the engine should be high, or stating it in another way, that the center of weight of the engine should be low, and coincide as nearly as possible with the center of thrust of the propeller, which is, of course, at the engine shaft.

If the center of gravity on an airplane be low, then the striking angle from the point of contact of the wheels to the center of gravity of the plane, Fig 5, will be considerable. If this angle is small there is less danger of nosing over. If it is nearly 90 deg then there will be a great danger of a somersault, hindered only by the area of the tail surfaces. A requirement for safe landing, therefore, is a low center of gravity, and large area and leverage of tail surface.

With the floating type of slow-landing machines there is just as much risk of accident with the machine but less danger to the occupant on account of the slower speed.

There is real opportunity for study and research to devise such mechanical arrangements—different from those now in use—as will enable higher speed landings to be made, and with quick stops.

This might be accomplished with a brake, on the floating type of machine. An air brake will not do, as at the slower speeds it would have to present, presumably, too great an area to be effective. A ground brake will not entirely do, because at the time the machine first touches the ground the pressure on the wheels and skid is so small as to be almost ineffective. To apply brakes to the front wheels would be like striking a bump, and would probably mean a spill.

I am not stating how this problem of landing is to be solved. I am merely mentioning it as one of the present-day problems of aeronautics that we can well consider as of first importance.

In studying landing remember that if we can add 10 m.p.h. to our landing speed we can add 20 miles or more to our flying speed. The ideal machine, of course, will be one of sufficient area to make a successful "pancake" landing, but machines with wing loading light enough to accomplish this feat are, with our present knowledge of structure, not within reason.

This brings us to the accessory parts of an airplane, some of which need to be redesigned and others will probably be eliminated.

The landing gear might be called an accessory, and very shortly this will be of the folding type, so that the head resistance can be eliminated, or at least partly so, as soon as the plane has mounted into the air. To date no experiments have developed a structure strong enough and light enough to do this.

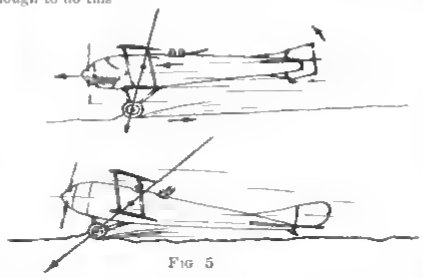


Fig 5

The matters of armament, or wiring, or carburetion, and of instruments are being taken up, but in spite of their extreme interest have no place in a published discussion at this time.

It is very probable, however, that the airplane will before long be a more accurately navigated vehicle than the ships of the sea.

Very little trouble is had with engines today, either in aircraft or automobiles, and little trouble with planes or with automobile chassis. The main difficulties come in connecting the two, in putting the engine into the plane or the car. As I have stated, we are now getting a great deal of experience in making these connections.

The greatest difficulty, as concerns gasoline engines is with the radiator. In order to function properly this must have air and plenty of it, and yet must be so arranged as to offer, theoretically, no resistance to forward travel. It must cool successfully on the ground at 100 deg in the shade, and within twenty minutes meet the same requirements at zero weather and high altitude.

Recent developments in air cooling indicate that for certain types of machines a great deal will be done with engines without radiators, there being particular advantage in air cooling for aircraft, in that moderate temperatures are always available at the high altitudes at which one ordinarily travels.

The heart of the airplane is undoubtedly the engine, and with this great progress has been made. All discussion of planes themselves, however, has shown that the engine in spite of all has comparatively small influence on speed-range performance. Weight per horsepower rather than total horsepower counts in an airplane, and this also must include the fuel necessary for the type of work that the plane is to do.

Planes with engines of 40 hp are practically equivalent in climb and speed to planes with five times that engine capacity. The difference comes in the amount of load that can be carried, which again indicates the distance that the plane can travel without refilling the fuel tank.

It is just as foolish to expect a bomber machine to go faster and to be more agile than a speed scout, even with its tiny engine, as it is to expect an ocean freighter having

engines of tens of thousands of horsepower to outdistance a speed boat with only a small gasoline engine. The difference in cargo capacity, however, is tremendously in favor of the bigger-powered ship. The same is true in aircraft, and as progress lends the way and experience dictates, aircraft probably will become larger and larger even for speed performance. Each design will be specialized for its own particular work and having engines of maximum horsepower to fit the maximum load requirements.

The engine, since it was begun in the automobile, is a line of effort in which we have already accomplished much in this country. It is one of the few parts of airplane research on which we had data at the start. We have learned much about aircraft engines, however, in the last year. We have learned a number of dynamic requirements which the automobile engineer has never met or had experience to analyze.

Experimentation with engines during the past has followed two major lines: the first aiming to produce an engine of lighter weight for the same horsepower, the second to greatly increase the horsepower for the same weight.

The first school—having its beginnings really with the Gnome rotating air-cooled engine—has developed rapidly, but has been hindered in obtaining high efficiency per cubic inch, in spite of the great number of cubic inches per pound of material. In the second school, on the other hand, as represented by the automobile type of engine, the weight per cubic inch has not been materially decreased, except in proportion to the cubic inches added to the engine, but the power obtained from each cubic inch of cylinder displacement has been tremendously increased.

In the school of engine design now coming into prominence the advantages of the lightest mechanical arrangement are being combined with the better theoretical construction of the automobile type which obtain the greatest power per cubic inch, this school is thus designing what must be very nearly the eventual type of engine, while aircraft are in the form in which they exist today.

One of the most prominent factories manufacturing rotating engines has been turned over to the manufacture of stationary radial engines, this seemingly being the beginning of the end for rotating aircraft power plants. Radial non-rotating engines of both air-cooled and water-cooled types are worth a great deal of effort today.

Receiving attention in all countries is the finding of some method by which an engine can develop its full horsepower at high altitudes. There are many methods of approaching this problem, and undoubtedly ways will be found whereby powers can be had at altitude equal to those obtained on the ground. Up to date, little has been actually accomplished along this line.

The chief difficulty in obtaining power at altitude is in keeping the proper amount of oxygen in the mixture and the proper initial volume of intake gas in the cylinders. Many methods of pump or turbo-compression and supercharging devices of one kind or another have been suggested, but up to date nothing has been accomplished.

And so I might go on through many fundamentals that have not even been touched on in this paper, and which involve new lines of research and study in materials and processes and the minutest details of construction. Enough has been presented, however, to establish those things that are basic in the future development of planes, and to start discussion to bring out further requirements and possibilities.

Today we know aerodynamics in America. We know production. We know what to do, and we know, in a large measure, how to do it. The problem is, then, first, to organize the efforts of this Government and this Society so that planes of production construction can be turned out in thousands, in knocked-down form for concise shipment, and gotten as soon as possible into action on the firing line; and, second, to devise new maximum ideas for the next step. Since America is at such a distance, and cannot hope to produce the latest maximum performance plane at once, she must therefore at present make up in tremendous quantity for what she may lack in individual quality, believing that a thousand 75 per cent planes are better than a hundred 90 per cent planes, or one perfect plane still on the drawing board.

When the engineers on this type of work have accomplished the result, and our planes are going over by the hundreds each day, and after we have the experience as well as the book knowledge of the intimate problems of aircraft creation, we will be ready for the next step, by American ingenuity to build those new planes and more ideal constructions that shall mark the end for Germany in the air.

We are living at the most interesting period of the world's history. We are facing the greatest opportunity that the engineer ever has had for achievement. Europe, recognizing in us the country that has created the submarine, the airplane, the steamboat, and the present major instruments for war, looks to us also, to the country of Fulton, Bushnell, Edison, Langley, Chanute and the Wrights, to create, with the Yankee cleverness which they recognize, the final air instrument for "strafing" the Hun. I am glad to say that America is rising to the occasion, and that our engineers are meeting the situation with remarkable success. Untold numbers of new devices of genius, scientific, accurate and wonderful, are perfected and almost in production, for the demoralization of our enemy, and we can feel confident that every problem that has been given the American engineer will surely and quickly be solved to the point of action.

Today a world picture is being painted, the background of which has been done blood red by the gory hand of Mars. The paint is not yet dry, and in looking at it one sees only red. There is a foreground, however, which civilization is now painting in delicate colors but with bold strokes, picturing a future of peaceful commerce and generations of happiness. Eventually the background must be covered, but for the time being, while sketching in the detail of that foreground which will be painted, progress seems slow. When the picture is done, however, and the primitive red shall be replaced by the delicate tints of dawn, by the green of the trees and the reflection of silent waters, and when at last the Painter shall lay aside his brush and step back to look over on the new world, may he see, through the foreground of happiness and peace and contentment, that middle background of achievement and sacrifice and conscientious judgment with which we are now concerned, as having enabled the foreground of Peace to obliterate the background of War that Life might take the place of Death, and Love of Hate.

Front View of a Farman Two-Seater Biplane, with a 220-Hp Lorraine Diétrich Engine

Airplanes of Today

By Fay L. Faurote

No subject, if we are to believe the press today is of more interest to the world at large, and the United States in particular, than that of aviation. This is naturally so because of its supposed vital bearing on the outcome of the war, and because it bids fair to usher in a new and yet unexplored commercial era afterward.

F. L. Faurote

When the Wright brothers, on December 17, 1903—only fifteen years ago—startled the world by their short but successful flight in a heavier-than-air machine, the most prophetic of us little knew the development that the next fifteen years would bring. The war came, and with it an accelerated progress, such as an industry has never known before, a mechanical activity of the most exciting sort, a marvelous awakening of invention, a speeding up of manufacture almost unbelievable; for despite what our critics say, huge steps have been taken, and still larger ones are in process today. The art of aviation has thrown off its swaddling clothes.

From the frail framework of the Wrights', with its little 16 hp. engine to the giant Handley-Page, Caproni and Curtiss machines is a far cry. Only a Jules Verne could have imagined or foreseen such an astounding development. War is a hard master, a driver of men and minds, a quickener of invention superlative. To what an extent it has hastened aeronautical development can best be realized by a survey of the hundred years preceding this century.

Early History

Literature shows us that as far back as the Prophet Isaiah men were thinking about a way to navigate the air. About the year 1500 Leonardo da Vinci and Jean Baptiste Dante, contemporaries of Columbus, are said to have given serious consideration to the problem of flight, and Dante is credited with having made a successful [illegible] bird wings which he had made after designs of his own.

Men of all ages have looked up into the air and wondered how and when they would be able to navigate it. But until fifteen years ago they did not know how. Limitations in their conceptions of time and space prevented them from solving the problem. But now, both time and space, with their attendant dimensional attributes, which are but mental concepts, are slowly being eliminated as man wakes up mentally. Inventive genius is gradually cutting down the one and decreasing the relative effect of the other. As has been the case with all other forms of progress, however, the world is loath to accept the new. The practicable plan of a real inventor is looked upon as a tuneful distortion of a disordered mind, and the earthly limits within which the public mind has been content to move give way only under the forced pressure of demonstrated design and practical operation.

It is a curious but natural coincidence that aeronautical development has in all ages followed, or has been accompanied by wars, or other great mental awakenings. For instance, da Vinci and Dante lived at the time when Columbus discovered the new world. Sir George Cayley, in 1809, made a huge glider and with it formulated many laws of equilibrium and control. He was at work during the War of 1812. Henson, Stringfellow, Wenham and Boulton—a quartette of experimenters who also made many valuable contributions to the art of aeronautics—were active just previous to and during the War of the Rebellion. Later, M. Ader in France, Sir Hiram Maxim in England, and our own Prof. Samuel P. Langley—then at the head of the Smithsonian Institution—were conducting scientific investigations, and making valuable experiments on machines during the Spanish-American War. This activity culminated in the successful flight made by the Wright brothers in 1903.

From that time until the beginning of the Great War some progress was of course made, but it is probable that had not the demand been greatly stimulated by the necessity of the Allies and Central Powers we should still have only small planes of limited power, carrying capacity and radius.

The strategic value of an airplane, however, quickly brought aerial development to the fore and artificially stimulated experimentation, development and manufacture, first in Europe and then in the United States. The discovery that Germany had for years been planning the building of giant Zeppelins, making aerial maps, designing and building airplanes and every aerial device connected with their use, shocked the rest of the world into the realization that if it were to compete successfully with Germany it would be necessary to build machines of large carrying capacity, of a speedy character and wide cruising radius. The internal combustion engine, brought to a comparatively high state of development by its use in the automobile, rendered this possible.

The Salmson Two-Seater Fighter

760

Handley Page Bombing Biplane

Conditions in 1908

To really appreciate the problems which five years ago engineers were called upon to solve, it might be interesting to take a look for a moment at the situation ten years ago—say in 1908—when most of the American flying machines were in a "featherless state," so to speak, when aside from a few exhibition flights, little of commercial value had been done. The Wright brothers, Glenn H. Curtiss, Chanute, Dr. Alexander Graham Bell, Capt. Thomas Scott Baldwin, Lieut. Selfridge, J. A. D. McCurdy, Charles M. Manly, and a few other pioneers, were all busily engaged proving the truth of their theories. The Wright brothers had met with some commercial success, and at military trials had demonstrated the worth of the airplane as a fourth arm of the service, thereby gaining Government recognition. Curtiss and Baldwin had made dirigibles and airplanes and flying-boats of various shapes and sizes. The Aerial Experimental Association had built three biplanes, the last one of which, the "June Bug"—at an official trial arranged under the auspices of the Aero Club of America, made the first publicly advertised flight, in July, 1908. The machine successfully flew 2000 yd. over an S-shaped course at a speed of 30 m.p.h.

Later, Curtiss made his famous flight down the Hudson from Albany to New York. As most of us no doubt know, there are few landing places between Albany and New York City. One was found near Poughkeepsie, which Curtiss used on his way down. Fearing that perhaps he might not be able to choose a landing place, and being unwilling to have his machine smashed on the rocks, he had some time before conceived the brilliant idea of putting on, in addition to his wheel-landing gear, pontoon floats, so that if worst came to worst he could land on the surface of the Hudson River. He said he always had a feeling that water might be safer to land on than the earth, and that at least he could land on the water without a bad smash-up if he had to.

Forward Portion of a Handley-Page

(C) *Underwood and Underwood*

Birth of Water Craft

This machine, which he later called "Triad," as therefore interesting as a forerunner of the seaplane and flying-boat, both of which developments he later carried to a successful conclusion. On Lake Keuka and on the smooth waters of the Spanish Bight just inside San Diego Harbor, he developed the flying boat and seaplane. It was here also that he came in contact with Army and Navy. Foreseeing the value of the airplane for army and navy work, he invited officers to be sent to his camp for training, and so during the winter trained many of the army and navy flyers who today are directing the destinies of our aerial forces. It was here also that he flew from land out to a battleship, landing alongside in the water, was hoisted aboard, dropped overboard again, and flew back to land. A year before Eugene Ely had succeeded in flying from land, in a land machine, and alighting on the deck of a battleship. It was at this time that both the Wright brothers and Curtiss demonstrated the possibility of aerial bomb dropping, and predicted that remarkable part that airplanes would play in any future conflict in which the world might become involved.

Early Design

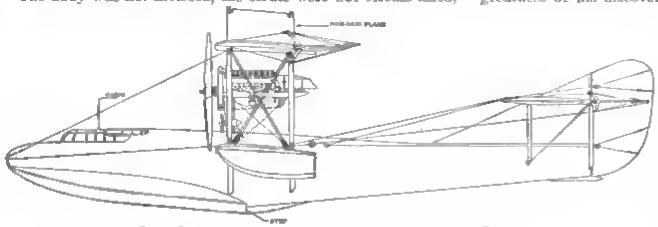
On all these early machines, as we will see, the pilots sat in an exposed position. Little attention was paid to resistance and stream-lining, and because of the fact that most of the machines were pushers, it was necessary to put the radiator well up to the

THREE-QUARTER REAR VIEW OF AN AMERICAN-BUILT LIBERTY D-H-4

front and between the wings and put the pilot and his passenger forward. Control systems were more or less fragile and unmechanical pieces of apparatus, designed to suit the purposes of the individual pilot. No attempt, of course, had been made to standardize them nor to work out similar movements for controlling the various surfaces.

Under-carriages differed materially as did the methods of getting off. The Wrights used a form of pylon and counter-weight for launching their machine from skids.

The body was not metooed, the struts were not stream lined,



SIDE ELEVATION OF A TWIN-ENGINED FLYING BOAT

neither was the under-carriage. The rudders were crude affairs, and the wing-panels, judged by the standards of today, were flimsy things of cloth and sticks.

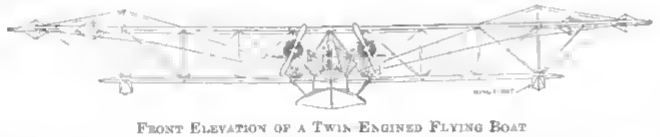
All praise to those brave men who risked their lives for the development of aviation! To the Wright brothers who—in spite of all odds, laughed at by friend and foe alike, at last had their efforts crowned with success, and from comparative obscurity placed their name, and that of Dayton, upon the lips of the world—I wish to pay tribute.

To me there is always in the character of every pioneer a certain something which inspires a feeling of awe, a certain far-away look, a prophetic cast of the eye almost childlike in its expression, that removes him from the crowd and causes him to be marked among men. It were as if God himself looked out upon the world through the eyes of his chosen few—inventive geniuses, reformers, great minds, they are, where do their ideas come from, where, indeed, if not from Divine Intelligence? Surely no human hand nor mind has trained their cunning, given them their starting point, perhaps, but what of their prophecies, their enlarged views—these alone must come from Above. They are the ambassadors of Spirit, so to speak, the human mouthpieces of Divine Mind, the wideners of the vision of life itself. As such they can no longer be considered as individuals, beholden only to themselves, they are the property of the world, the hostages of society, the almoners of inventive gifts for which the world can never adequately repay them. Modest to a degree, the true genius seldom realizes his mission, nor claims his own until the world, awake at last, honors, alas! sometimes too late to be of any real benefit to him. History alone develops the true greatness of his discoveries and grants to his memory the fitting crown of unselfish success.

At this point it seems proper that we should, for the sake of clearness, consider some of the terms of aeronautic nomenclature in order that in the illustrations that follow we may discuss with freedom the character of the various models. For the sake of illustration I have used the standard training machine known as the JN-4D. This machine is a biplane of the tractor type, a two seater, primary training machine equipped with a 90-hp eight-cylinder aeronautical engine.

Facts About the Theory of Flight

And now just a few words about the theory of flight. Many models and forms of airplanes have been studied, many experiments performed. The theory of flight is fairly well known, so that definite results can be predicted from certain known



FRONT ELEVATION OF A TWIN-ENGINED FLYING BOAT

conditions. Scientists and mathematicians have interested themselves in this branch of the engineering art, and M. Eiffel, Lanchester, Zahm, Hunsaker, Bryan, Bairstow and others have made many valuable contributions of facts upon which aeronautical design now securely rests. This scientific research has revealed many seemingly strange things.

Few people, for instance, know that about 66 per cent of the lifting force of the air is due to the suction on the upper surface of the wing panel, while only about 33 per cent can be credited to an actual pressure of the air on the under surface. It is also a significant fact that the force required to move a small wire through the air is as great as that required to move a stream-line strut several times its diameter. The influence of the stream-lining was formerly little understood and seldom taken account of in the design of struts, body and landing-gear. Scientific experimentation, however, revealed the necessity of cutting down head resistance, thus decreasing what is known as the "drag" or "drift." It indicated the necessity of changing the surfaces, the cross-section of the wing panels, the sections of the struts and other exposed surfaces, to forms which would offer less resistance.

Effect of Stream-Lining

It is easy enough to push a thing into the air, but it is hard to get it out without creating a disturbance. If we take a broomhandle, for instance, and sweep it through the air rapidly, we find, if we could examine the air immediately following it, that a small vacuum is created just back of the stick itself, and that eddying occurs directly behind it, creating a V-shaped partial vacuum which decidedly increases the total power required to move the stick through the atmosphere. It was early found by experimenters that by filling up this vacuum, and changing slightly the entering surface, the stick could be passed through the air much more easily: a considerably smaller amount of power would be required to move it.

Now, when we design an airplane we know before it goes up into the air almost exactly what it will do. We know, for instance, that a certain type of wing form has certain characteristics: one is good for weight carrying, another for speed, still another seems to combine successfully several desirable characteristics. Investigators have also discovered that what is known as an "end-wash" on a wing panel can be eliminated by cutting off the corner of the panel as indicated in the accompanying illustration.

Most American and Allied machines use that type of panel in which the end edges form an angle the apex of which points to the front of the machine, but Blériot has used a type of panel in which the angle formed by the end edges has its apex at the rear of the machine. Both types of panels have shown good performance. This latter type of end section is known as the Blériot end. The angle at which the wing panel meets the air is another subject of wide interest. The angle of incidence, for instance, which is the angle between the direction of flight and a tangent drawn through the lower surface of the wing panel, may be varied with interesting results.

Of course, the whole object of all this work is to decrease the "drag" and increase the "lift"—in other words, to secure a large "lift/drag," or efficiency ratio. Drag is always coexistant with lift, and is a measure of the waste energy that is spent in order to accomplish work. We cannot get lift without drag. Lift is a measure of the effective work, and drag is a corresponding measure of the amount of work absorbed or lost, and at the expense of which we get the lift.

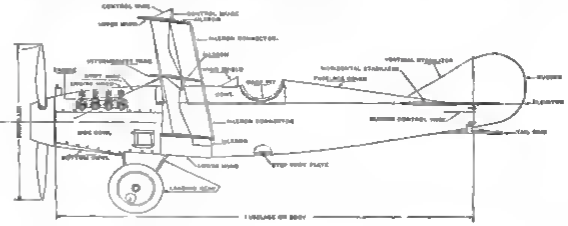
A biplane, if the wings are not staggered, is about 82 per cent as efficient as a monoplane of the same total wing area. A triplane is about 60 per cent as efficient for the same wing area. Taken at an angle of 4 deg., the following are the parts of the load carried by the planes: Upper, 0.45, middle, 0.20, lower, 0.35. A monoplane has 1.22 as much lift as a biplane and 1⅔ as much lift as a triplane. A biplane has 1.36 as much lift as a triplane. All of these ratios are on the basis of equal areas. The effect of stagger is to increase the efficiency of a biplane (relative to the monoplane) from 82 to 87 per cent, depending upon the stagger. For general purposes an aspect ratio of six is used. Fast racing machines usually have an aspect ratio of about six. For slower, weight-carrying machines, an aspect ratio of about seven or eight is used. The aspect ratio of the JN-4D is 7.3.

Some investigations made on dihedrals indicate that a considerable degree of lateral stability can be obtained by the

FRONT VIEW OF THE CURTISS PURSUIT TRIPLANE

same angle that would ordinarily be the result of sweeping back the wings. A somewhat superficial consideration of two or three wing sections may at this point be welcome, for instance:

The R.A.F. 6 (curve No. 1), developed by the Royal Aircraft Factory under O'Gorman, has been found both by wind-tunnel prediction and by actual tests in the field, to be one of the best lifting cross sections at a fair rate of speed. It has a fairly large range of stability, which is desirable in a machine flying at a normal rate of speed and with a considerable load. It is used in many of the heavier training machines. It is an excellent curve for hydro-work, inasmuch as a hydro-machine is generally heavier than a land machine for the same purpose.



SIDE ELEVATION OF THE CURTISS PURSUIT TRIPLANE

The Eiffel 32 cross section is of a generally slender form, which gives a fair lifting capacity and also a considerably greater speed than the R.A.F.-6, with the same expenditure of power and carrying the same load, the reason being that this curve is somewhat better stream-lined. Of all the curves that Eiffel has developed, the Eiffel 36 is considered the best. While the lifting capacity at the same speed is not so great as that of an R.A.F.-6 curve, its resistance at the same speed is considerably less. Therefore, with the same power at our disposal we can actually pull this curve through the air at a greater speed, and hence obtain the same lift with lesser area. On account of this, it is a faster wing section than the R.A.F.-6.

Scientists and the military authorities have developed and are today using curves that excel in all points of performance any of the three curves above mentioned. If the R.A.F.-6 curve, for instance, be said to have 15 as a factor of merit, and the Eiffel 36 be credited with a factor of merit of about 17½ to 18, we are using curves today whose factor of merit is about 22.

Classification of Machines

Modern airplanes may be divided into the following general types:

(1) *Combat Machines.* These are small, very fast, single-seater fighters, used for scouting purposes. They usually have wing spread of from 20 to 25 ft., a speed of 125 to 135 m.p.h., carrying capacity of 450 lb., and a climbing speed of 10,000 ft. in from 8 to 12 min. The Spad, Nieuport, Morane, Curtiss-triplane, SE-5, Sopwith, Dolphin and German Albatros single-seater are examples of this type.

(2) *Reconnaissance and Photograph Machines.* These are a slower flying machine intended for reconnaissance and pho-

tographic work. They are used for artillery spotting, map making and general reconnoitering. The wing spread is usually from 40 to 60 ft., and the speed from 80 to 100 m.p.h., the carrying capacity from 800 to 900 lb., the machines

A D-H 4 Fitted with a Liberty-12, as Seen from the Ground

being two or three seaters, and having a climbing speed of 10,000 ft. in 12 to 25 min. Examples of this class are De Havilland, Bristol, Curtiss, Voisin and Farman.

(3) *Battleplane.* The battleplane is a two or three-passenger machine driven usually by one large or two fairly good sized engines, and equipped with a number of machine guns and sometimes with a cannon. It is a moderately fast machine, making from 70 to 85 m.p.h. The Voisin is a good example of this type. It is credited with carrying a one pounder.

(4) *Bombers.* These are of the same general type as the reconnaissance machines, but slightly larger. They vary in size from 45 to 90 ft. in wing spread, and carry from two to twelve people in addition to their war load of bombs and fuel. Their speed is from 75 to 100 m.p.h., their radius of operation from 500 to 1000 miles, and their climbing speed 7000 ft. in 30 min. Examples of large bombers are Handley Page, Caprom, Breguet, the Caudron (a twin-engined French machine), the German Gotha, the Friedrichshafen, the German

Bristol Monoplane

AEG, and the big Curtiss boats. Machines that have been used for day-bombing and other purposes, but have lost their "pep" in remodeling, are many times used for night-bombing.

(5) *Flying-Boats and Seaplanes.* Various sizes of these are used for naval work. On account of the weight of their hull or pontoons these machines compare favorably with reconnaissance machines traveling at as high speeds as 90 to 100 m.p.h. Used for coast patrol work and for naval observation purposes, they operate from stations on the coast, battleships or mothership that accompany the fleet. Hydroaeroplanes are similar in construction to land machines, except that in place of the landing-gear, single or double pontoons are fitted below the wings so that the machine may rise from or alight on the water. Most hydroaeroplanes are lighter than flying boats. For that reason, where a craft is desired for inland water work or for short scouting trips, the hydroaeroplane is considered by many to be a very desirable type. Unlike the land machine, it is not necessary to fly high in order to pick out a suitable landing place; one can land on the water almost anywhere. For larger sea voyages, however, especially when it is necessary for the craft to remain for some time away from its base of supply, a more seaworthy type of hull is necessary.

The large flying boats, which the Curtiss Company has built in large numbers, are good examples of this type. These boats have a wing spread of about 90 ft., are about 46 ft. long, and have a hull shaped very much like a sulphur-bottomed whale. The hull is 42 ft. long, the inside is electric-lighted, completely equipped, and so arranged that one can move about comfort-

Bristol Biplane

ably. A boat of this size will carry a little more than 2000 pounds. I have been told by English officers that this boat has given a good account of itself, and that a large number of pilots have been decorated for their splendid work in attacking and downing Zeppelins in the Channel.

Conclusion

American manufacturers are not standing idle as some people seem to think. There have, of course, been many discouraging delays—many of which might have been prevented, many of which could not. I believe, however, that we are now fairly well on our way to good and continuous production.

Americans are known as great manufacturers and great inventors. American inventive genius always has, and I believe always will, continue to lead the world. Out of the brain of the Americans came the airplanes of yesterday and out of their brains will come, I believe, hundreds of improvements that will make the airplanes of tomorrow equally radical in their epoch-making possibilities.

We will win this war, why? Because it is a war of democracy against autocracy, a war of mental freedom against mental domination, a war of right against wrong.

Right will conquer, it always has and it always will. Humanly speaking, this war is a mechanical war, a war to be waged and won with machines directed from the air. It is a war that our *red* blooded young men, in whose hearts has been kindled the *white* heat of true patriotism, flying in the *blue* sky of an ever increasing democratic world, will, with the help of Almighty God, fight to a glorious and victorious end.

The Orville Wright Banquet

C. F. Kettering, president of the S. A. E., acted as toastmaster of the banquet given in honor of Orville Wright, at which speeches were made by Howard E. Coffin, Colonel E. A. Deeds, Colonel J. D. Vincent, Lieutenant M. Miozzi of the Italian aeronautics commission, F. G. Diffin, assistant director aircraft production, C. M. Manley, member of the American aeronautical commission to France, and Dr. S. W. Stratton, director national bureau of standards at Washington.

Fred Rike welcomed the visitors on behalf of the citizens of Daytoe as follows:

"I certainly must welcome the privilege as a citizen of Dayton of expressing our pleasure at having this meeting in our midst, and this afternoon as we stood over in the field here and watched the performances of the trantors, and then watched the performances of the battleplanes, it made cold chills run up and down my back, as it must have made the chills run up and down yours, and I felt that it must be a wonderful moment of satisfaction to our foremost citizen, Orville Wright, to see the fruition of the idea that he and his brother conceived and worked out, and it is a proud moment for Dayton on that account, and a proud moment for Dayton on your account. We hope you will come again."

Mr. Kettering then introduced Orville Wright, saying: "Our next speaker is a very linguistic sort of gentleman and is prone to talk too long. Therefore we had his speech printed in advance, but in order that you may understand it thoroughly I want to introduce to you our guest of honor, Mr. Wright." (Applause, the audience rising to its feet and indulging in prolonged cheering. Mr. Wright bowed his acknowledgment, but did not address his audience.)

Orville Wright
Photo W. P. Mayfield

Mr. Coffin's Speech

Howard Coffin was the next speaker. He said in part:

"There is one phase of aircraft work of which nothing has been seen here today, but to which the Aircraft Board's advisory relations were just the same as to the Army's activities. I refer to that of the Navy. The Navy has been building battleships and destroyers and telling us about how submarines have been sunk, but we have not heard a word about aircraft, and yet in many ways the Navy has done the most remarkable work along that line. They are flying every day aircraft weighing up to eleven or twelve thousand pounds, and equipped with engines of from four hundred to a thousand horsepower and carrying crews of five men. Commander Colburn has just told me that within the last week two of these Liberty engines were taken from stock, put into a stock boat, flown up and down the river a couple of times to make sure that everything was all right and then a trip was made of some 280 miles, from Philadelphia to Newport News, without missing a "shot" on either engine. I have seen them doing this sort of thing right along, and they think nothing at all of it. They are making almost daily trips from Newport News to Washington.

"When we consider the size of these boats and the power being put into them, we must wonder just what the limit in aircraft development will be. Of course, the Army is also at work on large machines, but the Navy, because of its work in detection of submarines, has started immediately with the large sizes. The new Naval Aircraft factory at Philadelphia has a floor space of about three-quarters of a million feet, and the work being done there is something that every one ought to see.

150,000 Men in Training

"Some 150,000 men are in training in the aviation service in this country, and there are twenty-five or thirty of the big training stations in operation. A laboratory in operation here in Dayton is one of the most remarkable developments of the whole air service, and perhaps most important of all, the mystery of aircraft production has been thoroughly exploded.

"Plants in this country are producing, and others will produce, aircraft of standardized interchangeable designs nearly as freely and easily as American plants have ever built automobiles. Those who visit the Dayton Wright plant will see a fine example of this work of interchangeability of parts. Airplanes are being shipped from this country in a disassembled form without markings. The crates, when received on the other side, can be opened and the parts assembled without any regard to the building operation on this side, and, as I remember, a cable received only a few days ago stated that within a few hours of the receipt of a certain shipment upon the other side, planes were assembled and the engines running.

"That is the way in which America will build airplanes. It has taken time to build the tools and the fixtures that have made it possible to manufacture interchangeable parts. One may realize what engine and airplane construction mean when it comes to keeping these machines in operation at the front, because no matter how many airplanes we ship to Europe if the interchangeable repair parts are not there, and if the men skilled in maintenance are not on hand, the machines will do us little good. We have heard a great deal said about the possible time loss in developing an American engine when it was seemingly perfectly simple and easy to adopt foreign engines, bring them to this country and put them in production, but if any one will show me an institution in this country that has adopted a foreign engine and put it into production in less than one to two years, then I will grant that the argument may have some force.

Liberty Engines

"After analyzing the situation and past experience from start to finish, it was decided that American engineers working in the American way, and with American machine tool designers working with these engineers, results could be gotten months earlier than if foreign engines were put into production in this country. I think it is a fact that can be borne out by any representative of the British service that after three years of war, with some ten thousand men in the main works, the leading British company is producing fifty engines

per week, each develops fifty horsepower less and weighs one hundred pounds more than the Liberty. Now that gives a little insight into some of the arguments leading to the design and putting into production of the Liberty engine. It is America's purpose to build engines not only for our own Navy, our own Army, but for foreign countries as well. There is a great difference between fifty engines a week and fifty in one hundred engines a day, an output any one of a half dozen of the plants of this country plan to be producing inside of the next ninety to one hundred and twenty days.

C. F. Kettering

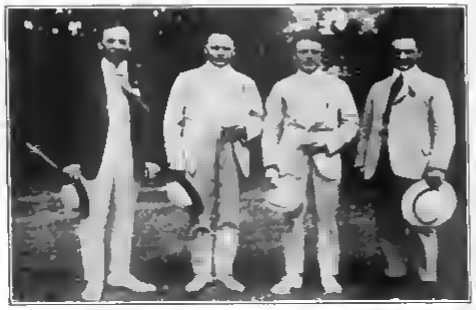
"Leaving aside all such accomplishments as increasing the spruce and fir production to some 15,000,000 ft. a month, the construction of the flying fields, the building up of personnel, the building of plants for the production of chemicals, the building up of industries for the production of accessories—those who have seen the planes on exhibition and who will see them at the Dayton-Wright plant will learn that the engine and the airplane are perhaps the smallest parts of the job. The wireless, wireless telephone, bomb dropping apparatus, oxygen tanks for breathing at high altitudes, electrically-heated clothing, generators, flares for landing at night, scientific instruments for recording speed, altitude, inclination, and a half dozen other things, synchronized machine guns—practically none of these were produced in this country a year ago. An industry has had to be created in almost every instance. Just leave aside all these matters and perhaps three major things have been done. One of them is the development of the Liberty engine. When I say development of the Liberty engine, I mean, as Major Vincent told us in January, the production of a Liberty cylinder which would be so perfect that it might go through the war without change and which could be used in any number or combination of cylinders on such engines as it might be decided to build. Let us call the Liberty engine one accomplishment.

Douglas Fir Better Than Spruce

"We have heard a good deal lately about the Irish situation in England, and that the linen situation was tied up with it. The English aircraft production was dependent upon this supply. The development in this country of a substitute for linen made of Sea Island long staple cotton, which has in actual test been proved the superior of linen, is another of the great influences in the development of aircraft and the participation of aircraft in the war.

"A third one is one that we perhaps had to force upon some of our Allies. Because of the spruce shortage we insisted that satisfactory aircraft could be built of Douglas fir. By force of necessity our Allies were obliged to begin using Douglas fir. The latest experiments have shown that Douglas fir is not only the equal of spruce, but is probably the superior, so that very much of the spruce difficulty will be removed.

"It has been an unfortunate handicap in the air services from the beginning that the matters of censorship have been so exercised that the truth of the difficulties and accomplishments could not be told. This very fact, I think, has been largely responsible for most of the exaggerated stories which



Messrs. Ericson, Pearson, Duffy and Ashworth

have certainly been contributing causes to the misunderstanding of the situation now existing in many sections of the country."

General Kenly's Remarks

"It is a great honor to have Orville Wright with us here tonight. I had the pleasure ten years ago of seeing the original flights made by the first Wright machine. Of course, in the brief period a marvelous advance has been made in aeronautics.

"I don't know whether you gentlemen are aware of the restrictions of the War Department upon what officers say in public. We are not supposed to say anything to anybody

Howard Coffin

Commander Richardson

Major Hall

F. G. Diffen

on any subject. This being a S. A. E. dinner, I will, however, tell you a brief story which seems applicable to the present situation.

"I have just been down on Long Island, where we are flying a certain number of D H-4 machines in coast patrol work—looking out for possible German submarines. There I heard a friend of mine, an exceedingly good pilot, instructing some of the young men who were flying the D H-4 machines. He said: 'You men have been flying a short time, four or five hundred hours perhaps, and you probably think you can fly a D H-4. Let me tell you, these slow boats that make 90 miles per hour are quite a different thing. With the D H-4 you pull back on the stick and the machine shoots you up into the elements.'

"I have the impression, from what I have seen here, that quite a number of D H-4 machines will shoot up into the elements before long."

GENERAL KENLY
Harris & Ewing

Colonel Deeds' Address

"After you have been in Washington about a year and have been investigated seven times, you don't shy at anything. My status is rather a peculiar one. You read once in a while in the newspapers something about a detachment of soldiers in no man's land. I think there are two or three colonels that I know of that represent that little saving about as well as anything I know. Colonel Waldron isn't with me tonight. I don't know what has become of one-third of General Gregory's army.

"I must follow tonight General Kenly's good example and not talk too much, but it is an inspiration to meet with you men here tonight.

"Washington is a great place. It is a great experience for a civilian to go there. Colonel Waldron and I were very much like that dise which you have seen down at Coney Island. If you stay in the middle, where you don't do much, it is pretty good, but if you get out where things are doing it isn't very long until you find yourself sliding off in a very undignified and ungraceful manner onto the sidelines.

"But some things have been done. Mr. Coffin has told us of some of the things that have been done. One very satisfactory thing to me is the fact that a Liberty engine does not read the newspapers. But it will be able to answer for itself in performance, and this may perhaps help some of us.

"The war won't end this year, and there are bigger, better things coming to this country as the result of this great conflict.

"If any of you have ever had come into your homes some great sorrow, some dear one taken away you find a new something has come there, something for the deepening of character, something that seems to give life a very different view from what you had before. I believe in our national life that the coming of these casualty lists is going to bring us a deepening of national character, something of regard for others, something of unselfishness, and something of that which makes for greater things.

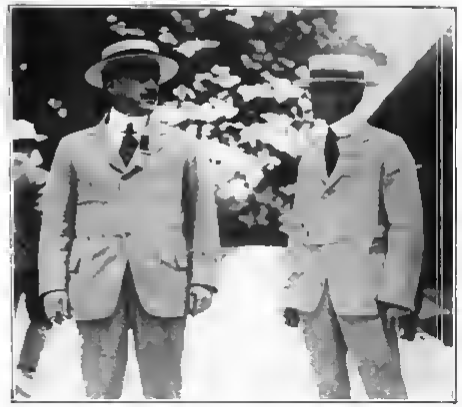
COLONEL DEEDS

"Things are moving. This great airplane industry is just in its infancy. I wrote Colonel Arnold a little card and asked how many miles were flown each day in our aviation training schools, and he sent back the memorandum, 'Over 220,000 miles each day.'"

Mr. Diffin's Address

"The first thing that impressed every one of us on our arrival at England was the whole hearted hospitality that was extended to us on every hand. We had the whole-hearted co-operation of every man that we met, and we met scores and scores of them in every branch of the work that we undertook, and it was wonderfully intelligent co-operation. We went over to show them something, but I think we came back learning a great deal from the tremendous work that we saw in England and France along the line of aeronautics.

MESSRS. COSTELLO, HANCH AND CALDWELL



S. S. BRADLEY AND B. L. WILLIAMS

"I am going to take the opportunity of a minute to outline to you the biggest impression that I got abroad. I feel that in this country we have woefully misunderstood the strength of Germany. I don't think that that strength is properly appreciated, what strength has been and what it is today. I think it is absolutely criminally foolish to expect an early close to this war, to expect that Germany could be starved into submission, to expect for one minute that the internal resources of Germany are anywhere near exhausted. It was evidenced on every hand by everything we saw over there what the tremendous offensive power of that country with her Allies is.

"It is ridiculous to anticipate internal revolution in Germany, as long as the Kaiser commands at least 6,000,000 bayonets. It is foreign to the education, to the upbringing of a German in in any way disregard authority. The most amazing thing that I saw was a German prison camp. Around it were a few strands of barbed wire. A boy could have crawled out of it. In there were several hundred German prisoners. I inquired why that wasn't barricaded. 'Why,' they said, 'the German common soldier respects authority, be that authority what it may. The French officers have told the German soldier where the deadline is and they don't go over it.' The German officer is another story. They hold him in with 16-foot barricades with highly charged wire around the top of it.

ELMER SPERRY

"The next thing that we have appreciated there is the offensive power of Germany in the air. We have all of us read and recd a great deal about superiority in the air. There is no question about the superiority of our personnel, but Germany spent years before this war started, in anticipation of an air war, and those years of anticipation were years of preparation. England and France today are getting pretty close to the limit of their productive capacity in the way of aircraft. We have got to supplant that capacity and bring what has been the newspaper dreams of the past into reality. One, two, five or ten thousand machines will not win this war for our Allies and ourselves, it will not win it for Germany. The side that puts the greatest number of aircraft in the air the quickest is the side that will win.

"Another conclusion that I reached over there was that on land it is going to be very largely a deadlock. They may win a few miles, they may lose a few. If we start driving them the other way, it is a long way to Berlin. But we can reach it in a few hours by air, or any part between there, if we only have the quantity.

"The greatest help toward getting that quantity of air planes is the education of the people in the United States to aeronautics.

"The biggest number of people in the country today don't know that an airplane is good for anything except a county fair stunt. Lots of those people are in Washington and every other city. The biggest help that every man in the S. A. E. can be is to go home believing fully in the doctrine that airplanes will not only help win the war, but will win it, and preach everything that he has seen in Dayton as applied to aeronautics, the wonderful possibilities, the offensive and defensive power that is in the airplane. The S. A. E. membership has got to preach that to every one that they know, every one that they see, all their friends, all their newspapers, and last but not least, their Congressmen and Senators.

"When that doctrine has spread, and not until then, will airplane production reach what I believe is a necessity, and that necessity is not a few thousand planes, but countless thousands. It is up to other departments of the Government to develop the personnel necessary to fly these machines. I don't think it is out of the way to estimate that if this war lasts three years more, our fleets of machines will be in the tens of thousands. It must be if we are going to win. Germany is certainly making preparations to reach those figures."

Dr. Stratton's Speech

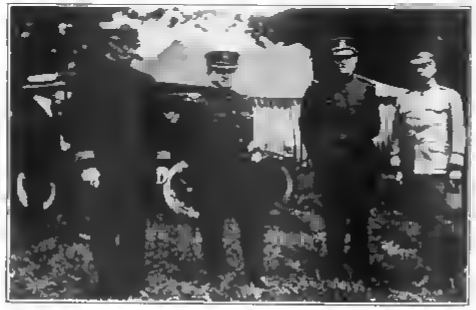
"It has been my good fortune to follow somewhat closely the development of the whole aviation program.

"As I look back over that program and see how you people got together and picked out a few things and stuck to them, any one knows, and it is no use for me to tell you that that is necessary for production in large quantities. Even some of our friends across the water have not learned that lesson, but it was absolutely necessary first to pick the industry that could do the job and then to settle upon the few good things that could be done.

"Now, then, after these few good things had been selected, it was absolutely necessary to meet a great many new conditions. I remember a short time ago reading a report by the British war cabinet, undoubtedly prepared as the result of an investigation similar to that of which we have heard this evening, and almost in the opening paragraph the statement was made that no engine after it was designed, after the model was settled upon and given, could be put in production under a year.

"Now, then, we have seen these people put these things into production in six or eight months in a few months, and it would have been absolutely impossible without first selecting the men who are accustomed to that sort of thing, who knew what American methods of manufacture were and without the backing of the members of the automobile industry that pulled it together and made this thing possible.

"There is another side to this thing that I would impress upon you. A great many people forget the fact that our Government is a a government by the people. We hear a great many criticisms of Congress, and we hear the members abused from time to time, but there is one thing that I always remember, and that is, that the members of Congress are exactly what you make them. They are the people that you send there, and if you don't like them, send others.



NAVAL CONSTRUCTOR COBURN, NAVAL CONSTRUCTOR WESTERVELT, LIEUT. BREEZE AND MAJOR WADSWORTH

"I want to tell you that it has been the organization of the disgruntled people, those who have had the good things that have not been accepted by the Government, that have been camping around Washington day and night and getting under the shelter of the capitol, telling all of these sorrowful tales about how their good things have not been accepted, etc. That has created the impression over there, whereas you people have been producing goods, and sooner or later, as some one has said here this evening, the Liberty engine will speak for itself. But it is a fact that those gentlemen do not know what is going on, and the unfortunate thing is that they will not go to the right people to find out.

"I have said many times in Washington to people in high places that they ought to go to the right places to find out what is going on and not to these disgruntled persons. I brought Secretary Redfield to Dayton, and he was perfectly amazed at the development he saw here. He has been telling about it ever since.

"It is a good plan for every one to see that his representative in Congress is posted. I don't care whether it is engines or matters of government. That is what they are there for, and those of you who know the truth of this story ought not to hesitate one moment to tell it to those in authority."

Kettering's Closing Address

The closing address of the evening was given by President Kettering. One of the thoughts he left was that it is the duty of the United States to settle down to some fundamental lines of making a few things and then making them in large quantities. He said in part:

"Now, gentlemen, I just want to say one word in closing. We have to do a few things, and one of them is to get the information which has been mentioned here at this table tonight out to the people at large. We have two great assets in this country—one our natural resources and the other our manufacturing ability. In reproduce in tremendous quantities interchangeable stuff, and if we are to give to this country the full measure of our ability, the full measure of our manufacturing power, we have to get it firmly before the people in authority at Washington, or wherever they be, that we have to settle down to some fundamental lines of making a few things and making them in tremendous quantities. If we do not do that we are going to waste time we are going to have more investigations, and we are going to have a lot of trouble, and in the meantime the Hun is going to keep on 'Hooning.'

"The thing for us to do is to get together, to get propaganda—if you want to call it that, to get people to understand what the real manufacturing problems are. I do not believe that anybody has the slightest conception of the tremendous amount of preparation that is necessary to produce a Liberty motor or an interchangeable airplane, and until they do get that into their minds they will never quit talking about 'we ought to make this, but we ought to make that.' What is the difference—we had better have a tremendous quantity of good stuff rather than none of the ideal.

There isn't an automobile manufacturer here that has had anything to do with the motor business but what kept on selling his this year's model, even though he had a better one for next year. We have to keep on making the things that we are making, and if there is a super-Liberty motor, let's wait until we get it before we talk about making it, and if there is a super-battle plane, let's wait until we get it before we start to make it.

"But while we are waiting and while we are idealizing, let's keep our factories running, and let's keep those things that we are making going over in tremendous quantities, and maybe after all we will find out that the super thing won't super as much as we thought it did, that what we are sending over there is very good. I have seen lots of engineers make an improvement on the automobile and have more trouble with it than the one they made the year before.

"So let's just build good stuff and get it over there in tremendous quantities."

B. B. BACHMAN

LIEUT. M. MIOZZI

C. M. MANLEY

The Menu

One of the unique features of the banquet was the quaint way in which the menu was gotten up in the form of blue print data sheets of the well known S. A. E. standard size, bound together with string. Each sheet contained a cartoon depicting some feature or function intended to interest and amuse. These menus were greatly appreciated by the members and guests who carried them home as novelties to be preserved as souvenirs with which to remember the very pleasant banquet.

Approximate Aircraft Figures

Date about June 10, 1918	
Airplanes at front bearing American insignia	378
Planes of American manufacture shipped to France	50
American aviators in France	1,746
American aviators fully equipped in France	126
American observers in France	1,800
Enlisted men of air service in France	38,367
Trained aviators in U. S.	3,467
Observers and non flying officers in U. S.	4,922
Enlisted men in air service now in U. S.	99,001
Capacity of 27 training schools in U. S.	3,500
In training at flying fields	3,394
In training at ground schools	3,393
Men passed by examining boards awaiting admission to ground schools	4,236
In advance training—pursuit, bombing or observation	1,036
In training at schools in France, England, Italy and Egypt	2,500

SCHEDULE OF ORDERS

Primary planes	5,300
Advanced training planes	2,100
Combat planes	11,000
Engines for primary planes	10,200
Engines for advanced planes	6,693
Engines for combat planes	27,300
Propellers	35,913
Balloons	1,077
Bombs	843,735
Machine Guns—	
4 to each combat machine	44,000
Spares and extras	20,000

DELIVERIES FROM AMERICAN FACTORIES

Primary planes	4,365
Advanced planes	620
Combat planes	300
Experimental planes	195
Engines for training machines	6,126
Engines for advanced machines	1,815
Engines for combat machines	1,500
Propellers	13,863
Machine guns	31,143
Balloons	125

The Aircraft Situation

While the time is past when it seemed advisable to emphasize the difficulties which have delayed the aircraft production during the past year, except as they may indicate a way of obviating these difficulties in the future, any survey of present aircraft production must refer to some extent to these difficulties.

One of the points which has perhaps escaped proper emphasis is that there has in the past been no open channel for information from headquarters. It is agreed that where a manufacturer could get into touch with headquarters, information could be secured. However, the great difficulty was to reach the responsible head. But the chances even then were that the information available would be incorrect or obsolete before it could be put into practice, on account of the fast following changes in information which were coming from abroad.

Our Allies did not at first seem to have a true appreciation of American manufacturing methods or difficulties. As a concrete example the commissions representing both our English and French allies at the beginning of our war made available to our Government all the latest information on their individual types of aircraft, and while these officers sought to closely cooperate in every way, the English and French views were in most cases divergent, and the representatives of the two governments were unable to avoid an endeavor to dispose of their respective viewpoints on the innumerable types of machines for varying purposes. The Americans had no real military aeronautic practise to start with, and were depending upon this information from abroad. It was only with the utmost difficulty and with careful sifting and weighing and frequent change in decisions that a type of combined day bombing, reconnaissance, and defensive fighting machine was decided upon. The same difficulty has applied to every other type of machine which has been considered for the American aircraft program.

Concerning the Liberty Engine

The next step is the one, now familiar, that of securing a high-powered engine which could be standardized and adapted to American machine production methods. The result is the now efficient Liberty Twelve, the designs and production of which is really a notable American contribution to the war. Colonel Vincent and Lieut. Col Hall, who at that time were respectively connected with the Packard and Hall Scott companies, started work on the Liberty engine in May, 1917. As a result of their efforts and the efforts of their assistants, we have now gotten into production the highest powered twelve-cylinder airplane engine in the world. Both the Packard and Lincoln Motors companies of Detroit are now producing the Liberty Twelve in quantity, large numbers of which have at the date of writing been shipped abroad.

The Needyke and Marmon Company, of Indianapolis, and the Trego Motors Corp., of New Haven, Conn., will be in production within a few weeks. By the fall of this year production of the Liberty Twelve will have reached such proportions that a serious question of shipping facilities will be involved.

It is agreed among aeronautical men of experience that to produce a new aircraft engine which functions properly under the varying conditions of modern air fighting within a year is an exceptionally fine achievement, which criticism of the mistakes made in the matter of publicity and construction—now happily eliminated—should not be allowed to overshadow.

Colonel Vincent has stated that the Lorraine-Dietrich was the engine he had in mind as the latest foreign practise on which the then-proposed high-powered American engine should be constructed. Both he and Colonel Hall of the Hall-Scott Co. were confident that this engine, which had a bore of 5 in. and a stroke of 7 in., would be perfected and placed in production abroad. This is probably the only miscalculation which was made in the design of the Liberty Engine. The Lorraine-Dietrich has never been placed in production, as far as available information shows, although the Liberty Twelve, which is based on the Mercedes and the Lorraine-Dietrich, and the best engine practise available in this country and abroad, is now a proven success.

The contribution of the Hall-Scott and Packard companies to the construction of the Liberty engine has been definitely analyzed and published by the Government, with several supplementary items, all of which appeared in AVIATION AND AERONAUTICAL ENGINEERING.

The advertising department of the Packard company overshot the proprieties in trying to capitalize the work which Packard contributed to this engine. This should not detract from the substantial fact that Packard spent approximately $257,000 on the preliminary experimental work on the Liberty engine. The work was done in their plant rather than at the Hall-Scott plant in San Francisco, because of the great distance of the latter from sources of material, tools, and information, as well as from Washington.

The steel cylinders and interchangeable parts of the Liberty are the really big achievement.

The much-discussed 45-deg. angle was adopted by Hall and Vincent because they calculated it would lessen vibration on account of the peculiar impulses resulting from proposed cylinder engines of the vertical type and the usual angle. The criticism that the 45 deg. angle for the cylinders was adopted to facilitate the incorporation of battery ignition as opposed to magneto ignition is, upon the testimony of both Colonel Vincent and Colonel Hall, not the fact.

A recent test on twelve Liberty engines, produced by Packard and Lincoln at McCook Field, shows that these engines develop an average horsepower of 412 and demand a fuel consumption of 54 lb. per b.hp. Better results are admittedly obtained from castor oil for lubricating the Liberty, but high volatile mineral oil is accomplishing good results. The mineral oil has a tendency to choke the spark plugs in coming down from high altitudes with the engine shut off. The practise now is for the pilot to throttle the engine down instead of shutting it off, which in practise has eliminated this difficulty.

The problem of radiation for the Liberty has not yet been fully solved, although great improvements in this direction have been made in recent tests. The latest information from abroad indicates that the proper figures for radiation of the Liberty are .06 sq. ft. of radiation per hp. This ratio figures 280 sq. ft. of radiation for the 400 hp. engine, which is the present practise. The radiator manufacturers insist that the cooling of every engine is an individual problem which must be solved in practise, and in the case of the Liberty this is being so solved.

D. H. 4 and the Liberty

Very recent reports from an American officer who has just returned from the front are to the effect that our pilots, as well as the British and French officers who have flown the D. H. 4 with the Liberty engine, are very well satisfied with the performance of this plane and engine. Official information to this effect will be the final vindication of the Liberty engine. This is expected very soon, and should have the effect of finally quieting the self-seeking critics of this question.

Information which has appeared in the newspapers during the past week or so indicates that the Spad single seater fighter is returning in official favor; also that it has been decided to go back to the Liberty eight cylinder engine, which was abandoned as part of the aircraft program last October. It has also been stated that the Liberty Eight is to be substituted for the Twelve in the two place Bristol fighting machine, orders for which were placed with the Curtiss company.

These facts may be correct, but the final decision, according to first-hand information, is to be based upon the report of another American commission which has just sailed for England and France. This commission is made up of Colonel Marmon, in command at McCook Field, Dayton, Ohio, Lieut. Col. Hall, formerly of the Hall Scott company, and recently assisting the Dayton Wright company to get into production, and Mr. Willard of the Aeromarine Plane and Motor Co. The purpose of the visit of these gentlemen to our Allies is to gather information on the military situation so it may be applied to our own production of fighting machines of the single and two seater types, and solve the question as to whether large bombing machines should be placed in quantity production in America.

It is understood that three types of planes particularly are now desired by General Pershing, namely one and two-seater fighting (or combat) machines, and a twin engined airplane, lightly armored on the underside for contact patrol and ground assault work.

On the face of things, it would seem that there is now in Washington sufficient information upon which to base a decision upon all the points mentioned. It would also seem to be the most practical proposition to proceed to give definite "go ahead" orders upon the machines in regard to which there has been so much discussion. Mr. Kettering, the President of the S. A. E., struck the proper note when he said in his address at Dayton that a large enough number of 90 per cent machines would make good our part in the war, rather than seeking to secure perfection which will continue to involve serious delays.

It is interesting to note that the group known before the war as the "smaller" aircraft manufacturers, and who made up the greater part of the aircraft industry as it then existed, are now practically all in quantity production, while some of the large companies in other lines who were given contracts because of their great manufacturing capacity are not yet in production.

For almost six months after the entry of the United States into the war, only two of the companies who composed the ante bellum aeronautical industry received any Government orders. The official reason for this was that their facilities were small and they had no knowledge of quantity production, and it would take too long to develop their resources in connection with a program the essence of which was speed.

The encouragement which the smaller companies have finally received has almost exclusively been forthcoming from the Navy. Nearly every other manufacturer in other lines who was able to convince the officials of his ability to reconstruct some product in quantity was given orders by the Army before the older aircraft manufacturers secured any business. The Navy found that the Army had practically preempted the newer aircraft manufacturing resources of the country. As a last resort, and with a good deal of trepidation in official quarters, orders were placed by the Navy with the older part of the aircraft industry.

It is gratifying to a publication whose interest in aeronautics antedates April 6 1917, to see the old aeronautical industry gradually coming into its own. The ideas of the older aeronautical engineers are daily being vindicated. The aircraft program has swung around an enormous circle, and types of machines which were advocated by practical aeronautical men before and immediately after our entry into the war are now to be placed in quantity production. The "smaller manufacturers" have made good. Had they been given proper encouragement from the start there would be less reason to criticise lardy production today.

That the airplane manufacturers are actively getting ready for real production is indicated by the following summaries of several factories compiled from reports current in aeronautical circles.

Curtiss Aeroplane and Motor Corp.

While the production of training planes (estimated in excess of 3000) during the last year at the plant of the Curtiss Aeroplane and Motor Corp., Buffalo, N. Y., has been wholly satisfactory, there has been much disappointment in the output of British battleplanes also ordered from the Curtiss plant. Fewer than twenty-five thus far have been turned out.

Of course there must have been a reason for the delay because it is a matter of no manufacturing consequence to the Curtiss Corporation whether it produces battleplanes or training planes. That it has made the latter type in large numbers is conclusive evidence that it is capable of quantity production, and, as the difference in workmanship between the two kinds of plane is immaterial, it is necessary to look elsewhere for an explanation of the slow movement in Bristols.

One correspondent writing from Buffalo recently said:

"They were ordered to build Bristol battleplanes here, and the simple truth is that only a week or so ago was the word to 'go ahead' received from the Signal Corps. So the production of battleplanes is very small—less than a dozen. How much this is due to a feeling in Washington, based upon word from the other side of the ocean that the Bristol plane is out of date, and how much it is due to a concentration on the De Havilland plane, which is admittedly a better fighting type and being turned out in quantities at Dayton, one cannot easily determine. But the order to go ahead indicates that several hundred Bristols are wanted anyway, and the Curtiss plant is in a position to construct them rapidly."

After mentioning the difficulty in obtaining decisions from the designing engineers the same writer continues:

"But the achievement of the Curtiss plant is not merely its large output of training planes—for Amerus has a comfortable surplus now—but its work on hydroplanes with pontoons attached and the new style flying boats for the navy. The Curtiss Company has built a number of these for Great Britain and is turning them out by the scores for our own Navy.

"But the flying boat needs a fighting plane to protect it, and whichever way one turns the need of serviceable fighting craft appears essential, though in the waters surrounding Great Britain, where the hunt for submarines is carried on, it is to be presumed that the British are supplying defence machines to protect the flying boats as they locate the undersea boats and drop their depth bombs.

"These navy craft are all equipped with Liberty motors, which are working well, too. So again one discovers advantages of versatility in that much abused but nevertheless effective standardized motor.

"But a big plant like this cannot keep its organization together and all its working units intact on the small amount of work the navy will have, or merely on training planes, if a plethora in that type is being reached. It can be readily seen why so much confusion as to who is right or wrong in the whole aircraft business exists when things which I am about to describe happen.

"Last October drawings were ready for the immediate manufacture of the 'Spad,' or one-seated fighting scout. The month of November was wasted trying to make the Liberty motor fit this particular type, and finally another motor was being tried out when word came to stop building Spads. That word came from Gen. Pershing, and it never has been explained whether he was confident he could get all the scouts he wanted from the French, or he began to see that the scout was not going to be of much further use as a fighter. Anyway, the Curtiss people were to 'to build Bristol two-seated fighters, and had some trouble with the drawings. Finally in January, they started to make twenty-five Bristols, but it was decided in Washington that bomb-dropping devices, oxygen tank, heating instruments, flare lights, and other things be added to the equipment. The twenty-five were held up throughout March and April, and the 'go ahead' received early in the present month. The general impression seems to be that the Government is trying to make the Bristol do things it cannot do, and that the orders far this type will not be repeated.

"Now imagine an organization of several thousand men gotten together and specially trained, and then have changes—perfectly necessary perhaps, and inevitable—coming along to delay and disrupt the best laid of plans. It takes a long time to get drawings ready and models made after they are once decided upon, and unless on finishing one order the working force is ready to start in with the next order, employees cannot be kept. They will not be impressed or held if 'gaps' occur in production.

"The Government must keep an eye on the working force, especially when it is considered how much time and money is invested indirectly by the Government in training these employees.

"Congress and the people generally have no doubt been given the impression that much money has been spent. As a matter of fact, less than two hundred millions has actually been disbursed out of appropriations and authorizations many times that sum."

Continuing and reverting to the delay in turning out the Bristol type the writer says:

"They haven't been built apparently because Washington didn't want Bristol machines in a hurry, or possibly not at all. But the request for Bristols now has been renewed. Has any one planned what is to be built thereafter? The designs ought to be here now, but they are not. Success in airplane building will come to the nation that looks ahead and plans ahead and keeps its organizations of workmen and trained mechanics intact. The Curtiss plant has produced the bulk of the training planes and has done practically all the work for the United

States Navy—a splendid job on the whole—but the crying need is for battleplanes, and it is unfortunate that De Havilands, such as are being produced so rapidly at Dayton, were not ordered built here, or a Handley Page, or some other foreign type that is doing effective work."

The Glenn L. Martin Co.

One of the pioneer American aircraft builders who has obtained an important share of the Army aircraft program is Glenn L. Martin, formerly of the Martin Aircraft Co., of Los Angeles, and the Wright-Martin Corporation, of New Brunswick, N. J. Mr. Martin's plant, known as the Glenn L. Martin

MAIN FLOOR OF THE MAIN BUILDING, GLENN L. MARTIN CO.

Co., is located at Cleveland, Ohio. The machines on which the company is working are large bombing planes of original all-American design, which are to be powered with two twelve-cylinder Liberty engines. The new plant at Cleveland was especially designed for the construction of large planes. It is

SAME AS ABOVE, WITH THE SLIDING DOORS SHUT

a permanent plant of steel and hollow tile construction, 300 ft. wide by 220 ft. deep, with a mezzanine floor containing 2000 sq. ft., and a total usable area of 68,000 sq. ft. Specially designed folding doors enclose the entire width and height of the rear of the plant. The doors are so constructed that they telescope in each direction from the center line, so that the entire back of the building can be thrown open. Plans are completed for a 500 x 300 ft. addition to the factory. The company also owns 68 acres of land immediately adjoining the plant, which with very little grading will make an exceptionally level flying field.

The Martin organization includes Glenn L. Martin, Donald W. Douglas, Chief Aeronautical Engineer, George B. Fuller, Assistant Aeronautical Engineer, Lawrence D. Bell, Experimental Manager. These men are the active directing heads of design, experimentation, and production. Mr. Fuller was for three years with the Government in the capacity of aeronautical engineer. Mr. Bell was superintendent of the old Martin Aircraft Company of Los Angeles for seven years.

Dayton Wright Airplane Co.

The first company to get into production with American built combat machines is the Dayton-Wright Company, of Dayton, Ohio, which is now shipping an increasingly large output of De Haviland 4 machines each week. These planes go out fully equipped with all military and aeronautical instruments and accessories.

During the week ended June 15 the Dayton-Wright company shipped 82 complete De Haviland 4's, the rate of production varying from twelve to fifteen machines per day. Over 90 De Haviland 4's were shipped from this plant during the week ended June 22, and at the time of writing (June 29) the company had shipped over 300 of these planes to France, 50 of which had been set up at the front.

The production of these machines has increased materially each week for the past eight weeks, and unless unlooked for conditions prevent it will without doubt shortly go to thirty complete planes per day. At first the practice was to make a complete factory flying test of each machine for one hour at an altitude of 10,000 ft. The company is now making this flying test on every sixth machine. They are flown at Wright Field, the company's private flying field adjoining the factory, with complete military load, except bombs.

The company's factory at Moraine City is now practically an enormous assembling plant. Three neighboring plants supply the larger wood and metal parts, while approximately 40 direct sub-contractors are furnishing the other parts for the machines. The woodworking shop at the Moraine City plant is now in course of removal to a new building adjoining the main plant, which will give considerable additional space for assembling the machines.

The Dayton-Wright company has been laboring under the same difficulties as other manufacturers in regard to securing information, receiving an amazing number of changes, and awaiting final instructions to go ahead. The first De Haviland 4 was completed and flown last October, and had it been possible to decide definitely to go ahead with a lot of De Havilands without change, their present output would have been probably thrice the number of machines which have been produced to date. Production now is, however, going through at a splendid rate, and it will soon be a question of adequate shipping space for the planes rather than of weekly plane production, from this plant.

Dayton Metal Products Co.

The main source of supply for the rods and turnbuckles for the De Haviland combat planes, which are being constructed in various plants in this country, is the Dayton Metal Products Co., of Dayton, Ohio. This company has 2300 employes on its payroll, 500 of whom are girls, and has a maximum production of 25,000 De Haviland 4 turnbuckles and 6000 tie rods per day. There are 120 tie rods and 80 turnbuckles to this plane. Albert B. Hilton, Jr., is the active manager of this plant, which, in addition to the airplane work, is producing large quantities of ordnance material. The company has had the common difficulty in maintaining its skilled men on account of war conditions. To overcome this, in a measure, they are running a school fully equipped with automatic screw machinery in training men for their special work. Every effort is made to make the working conditions at this plant satisfactory to the employes. One of the features of this phase of effort is a completely equipped Red Cross department where minor or major injuries can be properly cared for by skilled doctors and attendants. One unusual phase of the Red Cross Department is the dentist's office. Mr. Hilton believes that a contended workman is not one whose teeth are in a poor condition.

The D. M. P. Company is working day and night shifts. The night shift comprises about one-third of the day force. Another interesting detail is a desire to assist its employes through the employment of an "employes' attorney." This functionary will exert his best legal offices to assist employes who have ordinary outside legal work, from the collection of just debts to securing the adjustment of matrimonial difficulties.

The tool department of D. M. P. Company produces most of the special tools required for the work which calls for a tolerance of .002 of an inch.

Aeromarine Plane and Motor Co.

The Aeromarine Plane and Motor Co., of Keyport, N. J., is one of the concerns which was known prior to the war as a "smaller" company. Since then, however, the company has grown to considerable proportions. The claim is made for this company that for its number of employes it is producing more complete machines than any other American concern. This is based upon a ratio of 100 men per machine per week. Their production is now approximately twelve Navy machines every seven days, which gives a total of twelve hundred employes for this company. The company is fabricating all the parts for the Navy machines, with the exception of propellers, turnbuckles, wire, and radiators. Nine complete machines were shipped from the factory during the week ended June 22. With each four machines one set of spares is completed, consisting of one and one-half pontoons to a machine, and enough wire, turnbuckles, cloth, ribs, etc., for two additional machines. In other words, the figure twelve represents nine complete machines and three sets of spares.

During the week ended June 29 the company produced ten complete machines and three sets of spares. The ratio of complete machines to spares can be stated in still another way. A complete machine equals 79 labor hours, a complete set of spares equals 82 labor hours. Up until June 26 the company had produced 50 complete Navy seaplanes in addition to spares. Their force engaged in productive airplane labor numbers between 800 and 900.

The usable manufacturing area of the Aeromarine Company's boat shop, panel room, dope room, and metal shop has been recently doubled, and in three months' time the company will be able to turn out from five to six water or land machines per day.

Lewis & Vought Corp.

One of the finest pieces of American airplane design and workmanship is found in the advanced training two-seater biplane constructed by Chance M. Vought, of the Lewis & Vought Corp., of Long Island City, N. Y. This machine has successfully passed its official tests at McCook Field, Dayton, Ohio. Its power plant is a 150 hp. Hispano-Suiza engine. The Vought machine is said to be the fastest machine for its horsepower of which there is any record. A very successful effort to streamline all external fittings has been made in this machine. The main plane fittings are all countersunk and covered over so that they offer no air resistance. The covering for these fittings is a small section of hinglass, making it possible to note the condition of the connections at any time. It is understood on good authority that the Vought biplane will be put into production on a large scale for an advanced training machine. Its high and low speed range is very satisfactory, landings which were witnessed by the writer being notable for the way the plane alighted. The start of several flights at the same time showed that these machines are able to get off the ground after a very short run, and climb at a rate which shows an ability in this respect in excess of some higher-powered foreign planes of similar wing area.

The Burgess Co.

Aircraft investigations at Washington developed the fact that production of Naval aircraft had progressed proportionately very much better than the Army. The Burgess Co. of Marblehead, Mass., has played an important part in the production of Naval aircraft. This company is now employing 1000 people, and is reported upon good authority to have turned out seventy training seaplanes for the Navy during June. The company is actually exceeding the Government's production anticipations, and they are making deliveries well within the periods contracted for. This company's contracts as their present schedule will be completed in the near future. Like many other companies, they are handicapped in not having large enough continuing orders to plan ahead. The organization at Marblehead, in charge of Frank Russell, is one that has done excellent work in the development of seaplanes along scientific lines. This organization is now devoting its entire energies to quantity production, which necessitates laying aside the designing of experimental planes, and this suggests a point which apparently is being overlooked in the talk about quantity production. The companies should have sufficient continuing orders to keep their organizations going at full capacity, but it would be for the best interests of the Government if when such orders were placed the airplane engineers should be encouraged to parallel production efforts with original design for future requirements.

Curtiss Engineering Corp.

To develop the airplane along scientific lines through experimentation based upon knowledge of military and commercial requirements is the purpose of the Curtiss Engineering Corp., of Garden City, L. I. The permanent concrete and steel buildings which the company has erected are divided into research and engineering departments, a complete reference library on the airplane and the patents affecting its advancement, a wind tunnel, and complete testing apparatus.

It is not the intention to handle production work at this plant after the war. Its entire facilities will be devoted to development work for the Curtiss company at Buffalo and for any other individuals or companies who may wish to make use of its facilities.

The company is at present doing production work for the Navy. The type which they now have in production at Garden City is a large Naval bombing flying boat, powered with two Liberty twelve-cylinder engines.

The L. W. F. Engineering Corp.

With a plant quadrupled in capacity to that required before our entry in the war, the L. W. F. Engineering Corporation of College Point, L. I., is now in production on Navy flying boats. These are large machines with one Liberty motor, equal to probably three training seaplanes. Production at this plant has reached figures satisfactory to the Navy.

The L. W. F. Corp. has been doing upon their own initiative some very interesting experimental designing as a fighting plane for the Army which embodies certain surprising and original features. One of these new models has undergone successful preliminary tests.

Fisher Body Corp.

One of the largest sources of production for day bombing machines is the Fisher Body Corporation of Detroit, Mich., which first began constructing airplanes on receiving an order for five hundred Standard J's. These machines, it is understood, were all completed prior to the close of 1917.

The company for some time has been working on the De Haviland 4's. It has more than doubled its productive airplane facilities, and is now in production on the De Haviland machine. About the middle of June the company had completed its first hundred DH-4's, according to reports. Stocks of parts are well ahead and when the company reaches its productive capacity the large bombing machine will be turned out probably at the rate of forty per day.

Government Test for Lanzius Airplanes

The Lanzius Aircraft Company recently shipped for official test three of their all-steel single-seater airplanes built on the variable angle of incidence principle.

Four of these machines were fabricated in six weeks under a conditional Government contract calling for a high and low speed with military load considerably beyond the range of any of the fast planes now on the fighting front.

These planes, in addition to the variable-angle principle, will be equipped with variable-pitch all-metal propellers. The principle of this variable pitch propeller has been successfully applied in the metal air screws which are now being manufactured in quantity to drive the radio sets on American combat machines.

A variable-angle machine is recognized as marking a great advance in plane construction. Paul Schmidt's machine was not a success because the shifting of the angle caused a shifting in the center of pressure. This has been avoided in the Lanzius machine by the original cantilever construction, with the axis in the center of the planes, which are controlled by a lever attached to a worm gear in the cockpit. The planes can be shifted with no more effort than involved in changing the gears in an automobile.

The first model of the Lanzius machine to be tested under Government auspices was flown at Langley Field about three months ago. It was a smaller machine powered with a 210 hp. 8-cylinder Sturtevant engine.

The principle of the machine was thoroughly demonstrated during this test and as a result the Lanzius Company were ordered to build four larger machines.

Washington Views on Production

For several weeks two separate investigations into distinct phases of the aircraft situation have been conducted. They are still in progress. One outside of Congress is to determine whether, as alleged, there have been irregularities or criminal delinquencies, and one by Congress is making an inquiry into production.

The latter conducted by a sub-committee of the great Committee on Military Affairs of the Senate with Senator Thomas as chairman, has spent practically all the time since its appointment in personal inspections of and inquiries at eastern airplane plants for the purpose of securing data preliminary to the continuance of the inquiry with witnesses at Washington.

Until this inquiry shall have been completed and the committee's report submitted to the Senate no specific statement of the committee's possible findings will be made, but it has been permitted to become known in advance in a general and unofficial way that conditions have been found unsatisfactory.

This, if true, is regrettable, for it would seem to mean that much the same condition exists now as for months past had been found fault with both in and out of Congress, which led to the investigation of the whole program last winter, and which in turn eventually resulted in the recommendations that were one of the chief factors in bringing about the upheaval and reorganization which are now historical. In this connection there is, however, one hopeful sign, for while individual members of the committee are quoted as saying that present conditions are not satisfactory, they add that the point has been reached where production in quantity may soon be expected. That is better.

An interpretation of this comment is that the Bureau of Aircraft Production is not following beaten paths, but rather that under new management the program is rapidly progressing and that though the line of demarcation between production and quantity production has not yet been reached, it not only soon will be, but will also be passed. The whole effort of the Bureau is concentrated to this end. Its attitude toward the public is diametrically opposite to what their experience may have led them to expect. Semi-officially, it may be stated that the policy is and will be one of performance and not of promise and that there will be no official publicity, at least until production has reached a satisfactory stage and shipments have actually been made. A chart of accomplishment will then be hung on the wall as it were, that all who run may read, and reading, realize that while promise is often pleasing and exhilarating, performance is the better and stronger means to a desired end.

If it ever existed, the time has now passed when the American people can be camouflaged with roseate promises that the fabled pot of gold lies just at the foot of the rainbow. What they want are results. They expect, are entitled to, should have, and will be satisfied with nothing else. If the above version of the purpose of the production division is correct this is just what they will get—nothing less.

Commenting upon this and other phases of the subject, Hon. F. H. Dent, Jr., chairman of the Committee on Military Affairs of the United States House of Representatives, in a statement expressly prepared on June 24 for this journal, said:

"While I am not an expert on aviation or aeronautics, from the testimony before the Military Committee of the House, it is my humble opinion that this branch of the Army has played and will continue to play a very important function in the present conflict.

"I think it is somewhat unfortunate that rumors, finding expression in the press of the country last summer, induced the people to take too rosy a view of this branch of the service. The result was that the country finally became disappointed. As a matter of fact, while this branch of the service has not been built up as rapidly as it had been hoped, at the same time it has been by no means a failure. The information I have at this time is that production has now reached the point where the program can be successfully carried on.

"It is gratifying to know that the young men of the country were so eager to join this branch of the service that the Department had to discontinue enlistments.

"We have every reasonable expectation, however, that production is now upon its feet and it is believed that it will be a question of only a short time when this arm of our forces will be doing everything that the American people could desire."

While the Congressional debates which followed the investigation by the main Senate Military Committee developed what Senator Wadsworth might describe as a very large amount of variegated information, they also revealed facts and figures which are valuable in indicating the progress that had then been made in the air program.

These figures show that in a given week there were shipped from United States factories 110 primary training planes, nineteen advanced training planes, and seven combat planes, and also 241 primary training engines, nineteen advanced training engines, and eighty six combat engines (Liberty 12). During each of three other weeks there were produced respectively fourteen, thirty-four, and thirty seven bombing planes. In other words, in four weeks United States plants produced 211 primary, advanced and combat planes while England and France are credited with a combined monthly production of approximately 5,000 planes, of which about 3,000 are manufactured by the former, and 2,000 by the latter. This production further contrasts with United States requirements at the front, which are placed at 2,500 planes per month to meet replacements, etc.

These figures also show that at the time they were compiled the United States had in France, 1,639 planes of which 323 were combat machines, and 3,760 in this country, and that of the 13,000 machines which the United States contracted to have manufactured in France and England, the former number is all that had been delivered. It was developed that this country is manufacturing the Handley-Page, Bristol and de Haviland types of planes and that 107 de Haviland reconnaissance machines had been delivered to the United States.

Other information developed was that our single-seater pursuit planes are manufactured abroad, and that many of the machines of different kinds are made of American raw materials shipped to France and there assembled by American mechanics.

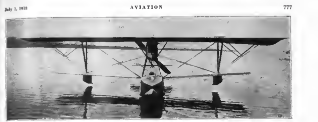
In regard to engines, a total of 1,041 Liberties had been delivered to the United States Army and Navy, of which 561 went to the former and 480 to the latter. Both France and England placed orders for the Liberty engines and of the 1,000 ordered by Great Britain eleven had been delivered. It was also shown that the Bugatti engine is being made at the factory of the Duesenberg Motors Corp., Elizabeth, N. J.

Information developed on machine guns is that the program calls for 220,000 in addition to 76,000 contracted for, that the Browning heavy airplane gun is being produced at the rate of 1,000 per month, that 1,500 Marlin airplane guns are available and 40,000 have been ordered, and that the Browning gun, which is synchronized, is to be substituted for Marlins for airplane purposes.

In addition to the above there is information from sources supposed to be official that plans have been practically completed for the manufacture by the United States of what is said to be a type of the fastest scout machine that flies. This is a late model of a British single-seater fighting biplane, the first of which appeared at the front about a year ago, and which is capable of doing every stunt known to flying. It is understood that this condition has been brought about by the inability of French and Italian manufacturers longer to turn out scout machines fast enough to meet the needs both of their own and our aviators and that if the United States is to take its proper place in assisting to acquire the mastery of the air we must undertake the work of making the light as well as heavy machines. The exact identification of this machine has not been divulged.

As to cost, the air account of expenditures shows that up to May 23 last $186,154,369 had been spent for planes, propellers and spare parts; $240,803,176 for engines and spares, and $28,496,912 for machine guns, and that the total of obligations for these and other things as of that date was $859,839,074.

From this data and other information, the deduction is that production is neither going backward, nor is it at a standstill, but on the other hand is going forward. It is gratifying to state that this condition applies alike to the Army and the Navy. Rear Admiral David W. Taylor, Chief of the Bureau of Construction of the Navy Department, who very rarely makes a statement for publication, permits himself to be quoted briefly to the effect that "the Navy's aircraft production is well in hand and shipments are proceeding with regularity."



A Study in Streamlining. Front View of an Italian Macchi Flying Boat—The Neat Engine Cowling of which is Particularly Noteworthy

Photo Western Newspaper Union

While complaints may have been justified at the time that much valuable time had been lost in trying to develop and standardize the Liberty engine, that factories were changed over and back again for the production of different engine types, that contracts for the manufacture of the Liberty were cancelled altogether or contracts for foreign engines substituted and that all these things, due to changes in plans in France, caused delays in the progress of the air program, they are now largely annulled by tests and expert opinion that the Liberty XII is in the first rank as an airplane engine. Similar criticism, for the same reasons, was applied to airplane factories, but in view of improving, but not wholly overcome conditions these, too, must now be somewhat modified.

On the other hand, there is still much complaint, and much evidence to justify it, that some airplane plants are now either shut down entirely, or are running under capacity and that some engine factories are not being operated at anywhere near their capacity. Promises of further orders are stated not to have materialized promptly, and yet manufacturers are not allowed to fill in with private orders. None realize the hardships this works so well as the manufacturers themselves. These are only a few of the criticisms heard. What can and should be done to relieve this situation and speed up production? One remedy lies in the adoption by the Government of a code of principles such as was printed in a recent number of Aviation and Aeronautical Engineering. It is reprinted here:

1—Orders should be placed at once for a sufficient number of planes to prevent the closing of productive aircraft plants. A continuing manufacturing program should be decided upon without further delay.

2—Immediate "go-ahead" orders should be given for the completion of a definite number of machines without changes.

3—Changes and improvements, where indicated by experience or necessity, to be made in the next specific lot of machines.

4—Full advantage should be taken of the experienced engineering and production experts of the aircraft manufacturers.

5—Substitution of materials of equivalent physical characteristics and strength should be permitted, when it is impossible to line up to specifications without involving delays.

6—A direct channel for the constant flow of information from the responsible Government official to the contractors should be opened. When an order is placed the manufacturer should be immediately given all available information regarding the particular machine or machines.

7—Orders for complete machines should be placed with responsible contractors who should be held strictly responsible to the Government under their bonds for the delivery of a definite number of machines.

8—Simplification of Government cost accounting methods in the plants, so as to eliminate innumerable minor and technical disputes between Government accountants and the manufacturers which result in retardation of production.

9—Original American creative work and design should be encouraged in every way.

These essentials to production reflect a composite of the ideas of the leading manufacturers themselves. With the supply of airplane parts, such as propellers, being in abundance and with the delays in spruce production being overcome, it is suggested that the quickest way to speed up production and get fully equipped machines into the hands of our aviators at the front, in the shortest possible time is for the officials charged with this duty to adopt and follow some such plan as outlined. Speed and more speed; airplanes and more airplanes; production and more production—these are the need of the hour. These only will justify the millions and billions of dollars appropriated by Congress for the support and continuation of the whole air program. In this way only can this Government keep the faith with the Allies and warrant the confidence of the American people.

The Airplane Problem

By An Aeronautical Engineer

Much has been written about the aircraft situation and its personnel both past and present. The industry has been the mark of investigators and the investigation of investigators, and now, at last, we seem to be safely started on the right path to production.

It is not the purpose of this article to criticize the administration's policy, nor is any criticism which is not constructive of any permanent benefit. It is not the intention, either, to give a detailed account of the status of aircraft production today. To do so might entail the divulging of confidential information, tending to give aid and comfort to the enemy. I shall do my best, however, to state briefly, and in a non-technical manner, some of the many difficulties attendant on quality production of aircraft.

The problem of the airplane is highly complex; many factors contribute to make it difficult of analysis. Perhaps for a full understanding of the situation which confronted our country on the declaration of war, one cannot do better than give a brief history of pre-war aeronautical engineering.

When the Wright Brothers on December 17, 1903, at Kitty-

Hawk, N. C., proved for all time that the flight of heavier-than-air machines was not a possibility but an actuality, they not only introduced us to a new era of locomotion, but also to an almost virgin field of engineering. To the end that they might not be robbed of the fruits of their labor, their methods were shrouded in mystery. The aeronautical world has not yet cast off this mantle of the unnatural.

The above statements have been made because they bear an indirect bearing on the questions of the present day. Even now, aviation is viewed with great fear by a large number of people who believe there is something uncanny and weird in connection with the conquest of the air. Engineers fail to consider aeronautics as a science because it does not fall under the definition of being classified knowledge.

A collapse of the wings of a machine in air is not due to faulty design alone, but to disregard of fundamental principles of mechanics which are unalterable. They apply as surely to an airplane as to a bridge. There is nothing new in the idea of an airplane structurally; the forces to which it is subjected are now quite well understood and the calculation of the stress in component parts becomes a mere question of the application of the rules of elementary mechanics. A stress diagram, based on reasonable assumptions, is quite a correct diagnosis of an airplane structure. The more or less "cut and try" methods of the Wrights have come down to some extent to the present day. There have been no wonderful radical changes in the machine as a whole, merely refinements suggested by practical experience and wind channel experimentation.

For the airplane as an efficient means of transportation, the old Wright Model B has never been improved upon, all gains in speed have been made at the expense of sacrifice of power. The question of speed, by the way, is the airplane's one chance of ultimate utilization, since as a conveyor, it can never hope to rival other means of transportation from an economic point of view.

From the Wrights' painstaking method of experimentation, the airplane passed into the hands of arch bicycle riders and daredevil performers who hailed the invention as a new vehicle with which to thrill a blasé public. Many of the trick manoeuvres of these aerial acrobats, such as looping the loop, and spiral dives have now become part of every cadet's flying curriculum, and proved just what a machine was capable of withstanding when in competent hands.

At the early period before the more recent exacting calculation and inspection of machines, this "stunting" led to many serious accidents; we were more prone to congratulate the flyers on their nerve than to feel increasing confidence in the safety of flight. Endeavors were made to promote the advancement of the art by flying tournaments and meets, but after the first effects of a new sensation had worn off, these efforts slumped for lack of financial support.

The first institution of learning of any repute to give the airplane consideration from a technical standpoint was the Massachusetts Institute of Technology which built an Aerodynamical Laboratory to house a four-foot wind channel in Cambridge, Mass., in 1913. This installation was almost identical with that of the National Physical Laboratory at Teddington, England, and at that time represented the best equipment obtainable.

The above layout with the wind channel and model basin at Washington constituted this country's research laboratories at the start of the war.

Prior to the declaration of war by the Allies in 1914, there were several dull years for commercial aviation. A few factories were started to turn out machines for exhibition purposes, and finally a very few for the Signal Corps, Aviation Section, and for the Navy.

When war was declared in Europe, aviation received its first real serious impulse since the time of the Wrights. The numerous orders placed with our few existing airplane plants by foreign nations were the cause of great expansion, and of the installation of scientific methods of efficiency and standardization. Probably one of the disagreeable effects of war orders was the introduction into the industry of many crafty financiers who thought to line their pockets at the expense of the Allies and employed engineers of doubtful knowledge to supervise the work from an engineering end. The engineers who worked for such companies gathered together more or less valuable information on weights and performances for their own personal use, as they migrated from factory to factory.

Such small information as there was, never found its way into book form. Indeed, an engineer's value to a company seemed to rest more on his reputation as a kleptomaniac than on his value as an aeronautical expert. Whether the machines they designed would fly or not was more or less of a gamble and depended more on the state of the company's exchequer than on inherent features of design. There was no clearing house of information in aeronautics as in other branches of engineering, a state of affairs which bolstered up the idea that there was not much known about aviation in a scissor.

Due to the complex character of fluid dynamics, there is perhaps no physical science where more empirical formulæ are employed than in aeronautics. Tabulated data on aerofoils, angles, full-flight performance of machines, weights, etc., are of the utmost importance. A logical system of units should have been adhered to for the purpose of forming a rational basis for future design and facilitating the comparison of the existing types of machines.

Thus the start of the war found us wholly unequipped as regards information and personnel. The number of true aeronautical experts in this country could probably have been numbered on the fingers of one hand. We had, at the most, two large aviation companies, the establishment of which, as I have pointed out, was due to foreign relations. It was to these meagre bureaus of information that we turned and asked for quantity production of aircraft.

The failure to produce airplanes under the old régime may be found not alone in the legacy of pre-war aeronautics, but in the appointment of many self-styled aeronautical engineers, and the desire of production experts to follow a Bible of automobile rules and to adapt apocryphal automobile production methods to the airplane. Many of these gentlemen brought qualifications in truck design and motor car accessories as an additional dowry when they joined the ranks of aviation experts. Perhaps some of these interests were not as keen to help the Government as to help themselves, perhaps, with keen insight into the commercial future, they judged the airplane their legitimate prey when the automobile had ceased to be such a lucrative source of income. By many it is believed that automobile production has reached and passed its highest point in this country.

The foregoing paragraph may seem irrevelant to the subject, and may be doing the industry a grave injustice. Without a doubt, phenomenally rapid expansion played the most havoc with the hopes of an air fleet in the early period of the war. In many factories, no attempts at order were made, and the stock-room methods were a disgrace to any system of efficiency. Production was the cry. Vast quantities of material were ordered and a large number of men hired.

Probably one of the important sub-items in connection with the rapid increase was the question of the draftsmen. Most of these men had never seen a machine, and some even lacked acquaintance with a common or garden scale. Thanks to careless dimensioning of parts for the shop, the assembly of more than one machine turned out to be a "cut out puzzle", and as was natural under the circumstances, the workman became skeptical of the knowledge of the engineers. The factories were to produce something—what they were to produce they were by no means certain. When the men in authority were told what was wanted, they were held up by lack of official "go-ahead orders."

Between civilian and military authority chaos reigned supreme. Orders were issued and countermanded, changes were ordered when the machines were in the assembly stage. Types were accepted and abandoned on advice of Intelligence Departments. Nowhere was there a semblance of order. What the industry really suffered from was the lack of the decision which comes with one-man authority.

In the adaptation of foreign machines, the draftsmen and mechanic question again appeared. One to the continental system of drawings and the fact that a large part of the final finishing and assembling is left to the workman on the other side, foreign drawings were an enigma to our workman, and their translation by our draftsmen and engineers seemed only to make matters worse.

Further, we lack the old world artisan and skilled mechanic. These men have been to a large extent replaced in our industrial ranks by automatic machinery. We substituted their motion, and to a degree their skill. But a machine is devoid of creative genius. Probably the most notable example of the old way versus the new is the Hispano-Suiza motor. This motor, while in quantity production on this side, could hardly be said to be a production proposition in this country until comparatively recently. It was only after many weary months of experimentation on many parts of this motor that it became a machine and not a hand proposition.

Perhaps an even better illustration of the difficulties of trying to design and produce an article at once and the same time may be found in the Liberty engine. This engine was supposed to have incorporated all the salient features of design of all known motors. Tools were actually made for the motor while it was still on the drafting board, and when the design was changed, they had to be scrapped as useless. Many models were actually constructed, and put into production before they had a reasonable chance to demonstrate their motive ability.

This prenatal influence was a serious handicap. It has been wisely said that the reputation of the first Liberty motor was killed by kind friends who talked it to death before it had shown the first spark of self-sustaining life or uttered its first official cough. The production of the Liberty to the exclusion of all other makes of motors was a mistake; it would have shown more foresight if we had guarded against failure by the joint production of several foreign motors of demonstrative ability.

It might well be asked at this juncture "Is the airplane a production proposition?" The rapid advance of the art causes so many changes in design that it is probable that, had it not been for the advent of war necessity, no immediate attempt would have been made to standardize parts, to say nothing of types. What are, then, the standardization limits? The limits which we cannot go beyond in quantity production without sacrificing the value and the time to be obtained by the introduction into the game of new types? This is a much mooted question. Its answer will come from "over there." Experience is the best teacher.

The aerodynamical efficiency of a machine and its fighting qualities must forever be a compromise. The answer cannot come alone from mathematical analysis or research laboratories; some of the theoretical controversial aspects of the airplane may well be left to a later day. We are at present more interested in the ability of aircraft than in their stability. In fact, excessive stability is of no great importance in a fighting machine; it may prove decidedly detrimental to its agile performance and quick response to controls. No time should be lost, however, in the standardization of bolts, nuts, lugs, wires and small fittings, as has already been done by the Society of Automotive Engineers.

The question of the relative value of analytical research and actual experimentation may well come up for discussion in view of recent developments. The French, who were in the front ranks as exponents of theoretical research in aerodynamics, and who had many well equipped laboratories prior to the war, have, if we are to believe technical gossip, abandoned most of their aeronautical laboratories within the last few months. They are reported as devoting themselves wholly to full-flight testing. Laborious calculations on the airplane structurally have been superseded by rigid sand load tests. In general, two sets of trusses are built for each experimental machine: one for sand-loading, the other for full-flight testing. It is by the employment of these more direct methods that much time is saved.

The English, on the other hand, have kept all their existing pre-war tunnels operating, and have added considerably to their equipment. The Britons still cling to their mathematical analysis of machines. But they have adopted continental usage to some extent, in the idea of sand load tests. It is rather disheartening to have to admit that today, the French have the better machines. It is true that they do not excel their Allies by much as regards speed or climb alone, but they are a better fighting proposition than any now on the front, with the exception, perhaps, of a few Italian machines.

The establishment of postal routes and mail service via air in this country is an excellent idea. It furnishes our men with cross-country flying experience, and tests out planes and engines. It is the nucleus about which we may develop the airplane until it occupies the place in our commercial life which it merits.

It is evident, then, that we do not want to lay too much stress on analytical research lest we find ourselves as England with her R. A. F. machines at the start of the war. The paper performance of these machines was truly remarkable; but all honors in the war have gone to Sopwith, De-Havilland, Short, etc.—in other words to the practical airplane constructors, most of whom combined actual experience in the air with mechanical genius.

Lack of production in the United States may also be laid at the door of poor specifications. The percentage of material lost because of super-rigid specifications was enormous. It is obviously unwise to try to follow foreign material specification in domestic design. We have not had a chance as yet to develop some of the special alloy steels mentioned in their reports. This problem is perhaps more for the metallurgist and chemical engineer than for the designer.

There is still need of more first-class inspectors of lumber and other material, to the end that the amount rejected be brought down to a minimum, and waste may be eliminated. The establishment of a training school for army inspectors of material might remedy this defect.

It has been suggested that Army and Navy aeronautics be under one head, thus chief to be termed Air Secretary, and to have a place in the cabinet. This would seem to be an excellent suggestion and prevent the duplication of equipment and give more centralized control than exists today.

The founding of a committee or board to take care of inventions would seem to be a move in the right direction. For just as the Wrights were forced to troubadour their way through the courts of Europe extolling the merits of their invention, just so many laudable inventions are probably passed over today for lack of a real engineering court of appeal. It might be well, also, to found an engineering committee to take charge of propaganda of a technical nature. Enthusiastic and irresponsible newspaper correspondents would thus lose one of their pet diversions to writing scientific memoirs on subjects with which they are not even superficially versed.

At the present time we seem to have removed a large number of useless parts in our production machinery, and to have reduced the friction between military and civilian authority to a minimum. We are on the highway to success.

But, now that we are on the verge of quantity production, it might be well to keep an eye on the quality of the article which we are about to turn out in such large numbers. Inspections of the right kind should not be relaxed, and advisable changes in design should be made at opportune moments.

The question as to the best method of procedure in transporting our machines over-seas is still more or less under discussion. The two methods are, (1) crating machines, and (2), transporting machines under their own power. The reader will be surprised to learn that the airplane in "knocked down" state, ready for shipment, occupies approximately twice as much room as when erected. Its shipment thus presents a serious problem in these days of limited shipping accommodations. This question is so serious, in fact, that ways and means are now under advisement to discover some plan by which the machine may itself become a vehicle of transportation. The selection of intermediatory flight stations is under consideration. The first trans-Atlantic flight seems to be only a question of a short time.

A glance at the situation today shows that much work has been done, and a great deal more remains to be tackled. The aeronautical world is alive to the issue at stake, and is anxious to expedite both the production and shipment of planes. We are eager to make good our promise, though at a later date than anticipated, with an apology for the delay in the form of overwhelming numbers of machines as a combined answer to our critics and a challenge to Autocracy.

Aeronautical Patents

GRANTED MAY 14, 1918

1,265,750—To Lloyd C. Gibson Atlanta, Ga. Airplane.
1,265,797—To Henry Lurz Jersey City, N. J. Kite.
1,266,151—To Nicholas Pogolski Washington, D. C. Airplane.
1,266,328—To Charles Frederick Smyth New Haven, Conn. Balloon valve.
1,266,341—To Charles E. Stitzer Denver, Colo. Gravity-stabilizer for airplanes.
1,266,408—To Herman Ludtke Morris, Ill. Parachute.

ISSUED MAY 21, 1918

1,266,746—To Lewis G. Yeager New York, N. Y. Airplane.
1,266,883—To Paul Robert Wagner, New York, N. Y. Flying machine.
1,266,936—To Joseph Preatka New York, N. Y. Flying machine.

Manufacturers Make Production Suggestions

That the manufacturers, large and small, are intent on rendering all possible assistance to the Government in pushing the aircraft program to a successful termination is evidenced by the many letters printed below. These letters apparently were written with the single thought that helpful and constructive criticism will be appreciated by those who are responsible for the successful conduct of the great task of securing an adequate production of aircraft. There is an entire absence of condemnation for past mistakes—the main thought is to secure ample production for the future.

That there has been a great improvement, that production has actually commenced is certain, and before long this production is bound to be greatly increased. The period of greatest difficulty is believed to have passed, and manufacturers are taking a much more cheerful view of the situation. Of course, there are manufacturers who feel that they have not as yet been given proper consideration by the Government, believing that their facilities and experience entitle them to share in the work. Their opinion is that the plan of utilizing the smaller aeronautical plants to some extent has worked out in a most successful manner, particularly as some of these factories are ahead of schedule in Navy work.

While no opinion has been expressed on the advisability of manufacturing the four, six and eight cylinder Liberty engines, it is thought in some quarters that this is a proposition that should be carefully considered, inasmuch as their reliability, light weight and ease of production should properly fit them for uses for which the Liberty 12 is unnecessarily heavy and powerful.

It is evident that manufacturers are willing to do their utmost to assist in every way the aircraft program, but some of them strongly express the opinion that the cost plus system is undesirable, tends to decrease efficiency, creates labor discontent and is unnecessarily expensive. There is also a demand that continuing orders be placed so that factories may be kept in steady production and thus secure efficiency in quantity and cost.

The letters which follow contain many suggestions that are of value, and reflect the views and sentiments of manufacturers who are anxious to do their part in aircraft production.

John L. Alcock & Co.

We were interested in supplying Pacific Coast silver spruce and West Virginia spruce to airplane factories up to about eight months ago. The Government then commandeered all this lumber direct for the manufacturers, and as merchants our business has been completely stopped.

We felt for a time the business would be subject to the control of the Government, and that we should be able to continue our business, but later development showed that the Aircraft Board considered it necessary that all transactions should be direct with the manufacturers, and, this, of course, eliminates entirely that portion of commerce which was conducted by merchants, and which contributed so much to the development of commercial relations throughout our country, and also throughout the world.

American Bronze Corp.

Our experience with the Aircraft Board and all of its subsidiaries has been most satisfactory. We have encountered nothing but the promptest acceptances of suggestions as to tests and any recommendations we have felt justified in offering have been given the promptest consideration and action.

The inspectors who have visited our plant have been unusually capable men and were not slow in recognizing the sincerity of purpose which actuates our production. We have found every division of the Aircraft Board, with which we have come in contact, always ready and willing to thoroughly investigate any matter or suggestion we offer. While there have been some changes in the specifications, we know that these changes were made in the interests of standardization.

The only suggestion we could offer as to improving conditions and production would be to give the Aircraft Board the support to which present labor and production proves they are entitled.

E. G. Anderson,
Sales Manager.

American Sash and Door Co.

We are now producing 15 propellers per day, which output can be rapidly increased to 100 per day if necessary, and the Government inspectors are extended in their praise of our performance.

Unfortunately we have still under way the small order that was placed with us, and at the present time have nothing further definite in sight. We have hopes, however, that the new program will enable us to employ our organization and equipment which we have built up at so much expense at the request of the Government officials.

So far as the basis at which we are willing to manufacture propellers is concerned, will state that we have repeatedly tendered our plant or our services, or both, on any terms that might be acceptable to the Government, and this proposition still holds good and will, so long as it may be necessary.

F. J. Moss,
President.

The Cincinnati Lathe & Tool Co.

It has been our opinion for some time, that in every city or district, especially where such Government work is being done, as in Cincinnati, a practical mechanic, or one thoroughly acquainted with the work in hand should be appointed, with the proper assistance, to get the maximum production out of that particular district.

Those in authority should map ahead all the work that is to be done during the next year or so. Then, let the manufacturers interest, take hold of it and push to the utmost.

Regarding the cost plus contracts, believe by this time that most of us know what a bad taste it has left, especially in paying inefficient labor about 200 per cent more than their real earth.

During the past few months our facilities have not been used by the Government to the full extent, because, if absolutely necessary we could operate a night force and overtime. We here are very anxious to do our bit.

During the past fifteen years we have been devoting all of our time building Cincinnati Metal Working Engine Lathes, therefore, have the facilities and ability to produce such machines.

Dural Rubber Corp.

We feel that pioneer manufacturers of aircraft or equipment—the companies who were in business before the war and who have spent many dollars and valuable time in research should be taken into greater confidence by the Government—that is—if upon investigation they were found worthy.

Our particular field is the manufacture of rubber parts for aircraft. We have worked for several years and today are producing nineteen different parts all of which are being used by some of the largest manufacturers of aircraft.

We feel that under the present congested financial conditions the aircraft manufacturers should be instructed by the Government to give trade acceptances to sub-contractors. I realize fully that the Government will not, directly, give trade acceptances but they are greatly in favor of their use. This seems to the writer, off hand, an opportunity to use this admirable method of finance.

So far as our company is concerned, we have received no cooperation from the Government, either in experiments or acceptance of our products. We have not applied directly for any assistance. With us, it has been a matter of presenting our claim for each article to the aircraft manufacturers, experimental department and receiving individual cooperation. We gladly welcome any Government cooperation available.

Our plant is capable of manufacturing the rubber equipment of 75,000 to 100,000 planes, depending on model and size. This figure, however, would not include outer casing or exercisor cord. Some of these parts upon which we have worked for a long time but our real production has scarcely been touched. We are anxious to increase our volume of business.

E. H. Wilson,
President.

J. A. Fay & Egan Co.

As we fitted up the original factory of the Wright Bros. at Dayton, O., many years ago, and subsequently the Glenn L. Martin factory at Los Angeles, Cal. we quite naturally were called into consultation regarding equipment for the large airplane factories established in this country since we entered the war.

Our facilities are such that we have been able to ship from stock, practically all of the machines of the type made by us, required in equipping the new Dayton-Wright factory, Dayton, O., the enlarged Curtiss factory, Sturtevant, Thomas-Morse, West Virginia Aircrafts Co., Glenn L. Martin, Wright-Martin, Standard Aircraft Corp., Gallaudet, Boeing, etc., besides the many smaller equipments required by sub-contractors on parts, the Naval Aircraft factory at Philadelphia, and its bases abroad, the U. S. Army for its repair shop and experimental fields throughout the country, and what we have done in the way of quick deliveries in the past, we are ready and willing to do again.

At the same time, by cooperating with the production engineers of these different plants, we were able to re-design some of our standard machines into semi-special types for this work, developing a machine for cutting up without springing, the long stock required for longerons and wing spars, a high production machine for making stringers and wing web cops, another for building up laminated material for wing spars, another for cutting the holes for seating the aileron hinges, etc.

Quickly realizing that there was a lot of experimental work that would have to be done in order to develop special machines for this work, we shortly after the United States entered the war, cabled our correspondents abroad, to forward data on equipment used there for this work. As a result, through a special arrangement with the British Royal Air Board, one of the foremost engineering authorities on this subject, made a special trip to this country last summer, bringing with him, complete drawings, models, and other data on this work, and stayed here at our factory until fall, assisting us in getting these special machines into production. These machines are numbered as follows: No. 444, an automatic propeller shaper, No. 445, a universal vise stand; No. 446, an automatic propeller boring machine, and No. 447, an automatic strut forming and finishing machine.

We have already manufactured and delivered to the Army, Navy, and different airplane factories, a considerable number of these different machines, and anticipating a tremendous need for these special types, as their time and labor saving advantages are realized in this country, we have brought through a large quantity of each type, so that as soon as the appropriations for the new fiscal year are available and new contracts let, we will be in position to do our part, by making immediate shipment of these special and semi-special machines, and also of our standard types.

E. C. Schwertman,
Airplane Machinery Division.

The Fulton Co.

To date we have received no contract for airplane equipment, but proper officials are testing out at this time a number of different devices which we have submitted to them, and with one or two minor exceptions we are getting all the cooperation possible from those in charge. Since the new Aircraft Board has taken charge there has been renewed activity along certain lines, and we believe that important results will shortly be accomplished.

We have offered the services of our engineering staff and laboratory to the Government to use in any way they may deem necessary, and the officials were appreciative of the offer.

Regarding our opinion on the relative merits of the cost plus and the straight price contracts, we cannot condemn too strongly the former system, as we believe it demoralizes any organization or industry in which it is used. Our experience has been that cost plus contractors entice away the individual members of other organizations by paying exorbitant wages, as they of course make twice as much profit on a ten dollar a day man as they do on a five dollar a day man. Under the cost plus system there is very little incentive to keep the cost down, or to keep the efficiency of the work.

The writer's personal opinion as to how production can best be increased and expedited, is that the draft law should be changed to include all men to forty-five and take workmen out of non-essential industries and place them in the essential ones; use more women on light production work; do not put any restrictions on standardization or time study and efficiency work; and require every man in the country to register with the draft board when he changes employment, regardless as to whether he is within the draft age or not.

Our facilities have not been used by the Government to their full extent, for the reason that our product is a very special one, and we must hold a certain portion of our capacity for particular work we are doing for the Government, and we could not afford to take on work that other concerns could do, and thereby preclude our producing special work mentioned. We are now building additional special machinery which will enable us to handle more work. We have no complaint to

make of any matters, except that with any large organization there must necessarily be a lot of "red tape," and this sometimes hampers operations.

WM. P. TOMS,
General Manager

Flottorp Manufacturing Co.

We have received contracts for quite a number of propellers which were obtained on account of our former reputation and good recommendations. The inspectors as a whole, have been very reasonable and in most cases they used good judgment, but it seemed to be with the Government the same as with the manufacturers, they cannot always obtain experienced men, and for that reason it has been very much appreciated by this company that there is a traveling inspector, who has a little more authority and can adjust any matters that may not be entirely satisfactory.

We have had quite a few changes in the specifications and also in drawings, which has caused a little confusion in our factories, as it was impossible to change immediately and the inspectors insisted that the change should be made as soon as the new specifications was received, but this has been taken care of in a satisfactory way so I do not think we will experience any future trouble. We have been permitted to finish up material that had been started in accordance with old specifications and blue prints, and only had to make the change when we got our plant and material in such a shape that it was possible.

Obtaining material, acceptance of our productions, and securing financial remuneration has been very satisfactory. It is a surprise to me that the Government has been able to eliminate the red tape to the extent it has. I think everything is running fine in our line.

I believe the straight price contract has a tendency to stimulate production and lower the cost, if the contractor can get sufficient orders ahead so as not to be compelled to lay off his man, after they have been trained for particular work.

This company has facilities for increasing its production about five times, if we are assured of steady work for a considerable length of time and we would be very glad to do all in our power to get the production up to this mark.

OLE FLOTTORP,
President.

Kawneer Manufacturing Co.

In the rush and anxiety of war production, it is necessary that we frequently survey the situation to see just how much progress we have made.

Those not conversant with airplane construction can hardly realize the problems confronting this young industry when our country entered the war and, almost over night, called for huge production of aircraft. Our Army had few aircraft standards. Those we had, were for the most part rendered obsolete and useless by the experience of our Allies in the early months of the war.

Our problem was to adopt light gage steel to take the place of other material which was difficult to obtain and to standardize parts so production would meet the immediate requirements of the constantly growing aircraft program.

Our three metal working plants were engaged, even before our country entered the war, upon the problem of adapting metal to airplane construction and we have a pardonable pride in the success we have obtained. Our organizations are now working at top speed turning out metal parts for the larger airplane producing companies. These metal parts, which we are now furnishing as standard construction, include rudders, elevators, vertical and horizontal stabilizers, fuselage parts, struts and braces, and trailing and leading edges.

The next few months will see some wonderful developments in aircraft production. It has taken time to work out experiments and establish standards. This field has required large creative development and constructive work. Now that these preliminary hurdles are successfully passed, the straightaway will find this industry meeting our increasing war requirements promptly.

Production on airplane parts in our plants has increased every week since we turned out the first set of parts. We expect that our production will show a large increase in the next thirty days. In a very short time we could, without doubt, more than double our present output. Our factory organization is being re-vamped as rapidly as possible to the point where we can handle an immense increase in aircraft orders. We are willing, if necessary, to place all of our facilities at the disposal of the Government.

It might be an opportune time to mention that at the same time we developed our production activities in aircraft work, we have also developed ideas in special construction, such as the "Kawneer" steel trailing edge and all steel tail construction. We are justly proud of this achievement, inasmuch as these ideas have received Government approval and have been very extensively adopted and applied, as regular construction, by the leading airplane manufacturers in this country.

Throughout the past year or more of constructive work conditions have arisen that in our opinion might have been improved. There have been what looked to us to be unnecessary delays, but perhaps that trite old saying—"Haste makes waste"—was made for just such a situation as we have been facing during the past few months. We must bear in mind that it takes time to organize and build a successful product in either a new or old plant. So when we created practically a new industry which demanded the utmost effort of a number of plants, it would have been too much to expect that the whole machinery would run smoothly from the start. It is, indeed, encouraging that we have been able to meet and overcome these problems.

F. R. EAGLESFIELD,
General Sales Manager.

Lawson Aircraft Corp.

During the past six months I have been furnishing to Congress a bi-monthly bulletin containing information for the different members of the House of Representatives and the United States Senate.

The principal object of these bulletins is to give to the gentlemen whom we have to depend upon for the cash with which to build airplanes for the United States Government a general understanding of the aeronautical situation.

Some of my messages to Congress during the past have been considered of sufficient importance by that body to be published in the *Congressional Record*. In some instances, however, it appeared to me that some of the members were rather skeptical as to the general outlook for the future of the aeronautical industry as I outlined it.

The different members of Congress, however, are not supposed to be specialists in the aircraft line any more than they are supposed to be specialists in any other line and so the only way that they can acquire knowledge along any particular line in which they have not had special training is through those who are directly interested in the subject.

Congress is willing to admit today the necessity of spending a billion dollars for aircraft because other nations have already expended anywhere from $2,000,000,000 to $3,000,000,000 apiece. These nations are France, Great Britain and Germany, each of whom has already spent from two to three, or even four, times as much money upon their air programs as the United States Government has spent upon its air program.

The day of the $1,000,000,000 air program is past, and our air program must be considerably enlarged if we expect to defeat Germany, who has already expended more than $3,000,000,000 on aeronautics.

Under date of March 15, 1918, I urged the members of both houses to consider seriously the appropriation of $10,000,000,000 to build and operate a monster air fleet with which we would not only be able to defeat the Kaiser, but also give us the only weapon that will defend this country successfully against all attacks of its enemies after this war is over.

There is no good reason for this country to continually drag behind such nations as Germany, France or Great Britain, and as all of these countries lead us at the present time in aircraft, it is about time we made up our minds that we would take the lead for a change.

So in the last analysis we will either have to condemn Congress for not having sufficient foresight to appropriate sufficiently large sums with which to build and operate great American air fleets that will defeat the Kaiser or we will have to give Congress credit for having had foresight enough to appropriate sufficiently large sums to do the job.

There is no question but that the manufacturers of aircraft in America will be able to perform their part of the undertaking, and that the American airmen will also be able to take care of their share of the work if the men at the top are able to look after properly their part of it.

THOMAS W. LAWSON,
General Manager.

Michigan Aircraft Co.

We take pleasure in submitting to you our opinion on the aircraft situation, and wish to call to your attention the copy of a letter which we mailed recently to the Aircraft Board. This letter shows that we are quite familiar with the present conditions, and, having been actively engaged in the aircraft manufacturing and experimental work for nearly eight years, we are sufficiently competent to express our opinion, which we hope may be of some benefit and have appreciable effect on the success of the new aircraft program.

Looking at the vast and difficult problems the Government must solve to increase production of aircraft, we can clearly conceive how tremendous this task is and can understand that countless difficulties must be surmounted before the abnormal call for airplanes is satisfied.

We are inclined to believe that almost immediate results could be effected if small aircraft manufacturing concerns were given an opportunity to secure orders for limited numbers of machines, and that in this manner much needed aircraft manufacturing facilities could be successfully developed. A moment of intelligent thought on this important subject would show that the few large manufacturing concerns in this country were very limited in size and resources, and that their output of aircraft in pre war times was practically negligible. Under the stimulus of war orders they developed into huge manufactories in short time, some of them employing thousands of workers.

Small aircraft concerns of today constitute the nucleus of our war aircraft industry of the immediate future, and we believe that they should be given small initial orders for aircraft, to assist them in the experimental work and coach them in their effort to win an important place in the aircraft industry, which is being forced on us in increasing proportion through the war.

The large centers of woodworking industries should be taken full advantage of. Through casual observation it appears to us that concerns engaged in furniture and piano manufacturing could produce and assemble wing ribs, frames for control surfaces and wings in great quantities, and it might be advisable to establish aircraft assembly plants, in charge of experienced personnel in each center of woodworking industry.

The new concerns unacquainted with war requirements and beginners in industrial fields should be given every atom of information in the Government's possession, so as to let them get straight on to the manufacture of aircraft in the most efficient manner. In addition they should have the privilege of entering certain aircraft factories which are known for their efficient production system, and there through actual observation gain additional experience that could be usefully applied in their own plants or factories.

To double the present aircraft manufacturing resources we must adopt part of our enormous capacity for production to aircraft work, and we can not afford to overlook any concern that shows any adaptability for aircraft work, no matter how limited its resources or how small its output.

The experimental work should be encouraged and experimental efforts of individuals or concerns should be investigated, and if found to be of merit should be sent to experimental fields designated by the Government for this purpose. With the assistance and co-operation of the Army and Navy experts, good and practical ideas could be successfully developed and valuable improvements secured.

The complicated and (to the Government) unfair cost plus system should be immediately abolished and replaced with the single straight price contract. It appears that the cost plus system if it is handled so as to be absolutely right, or as near thereto as possible, is very inefficient and expensive, and causes confusion and interminable delays. This system must be replaced with the more expedient and practical straight price contract eliminating all the red tape and unnecessary expense.

To eliminate delays caused by inability of the contractor to secure materials required for the building of aircraft, arrangement should be made with the manufacturers of materials to have stock on hand ready for immediate shipment. The contractor should be furnished with a list of firms that are nearest to him and that will supply him with needed materials at once and at the prices stipulated by the Government. It appears that a system of this sort, or similar to it, would eliminate cross shipments and long-distance shipments.

Only by undivided, persistent and intelligent effort can the desired upbuilding of aircraft manufacturing resources be accomplished. By eliminating red tape and co-operating with the manufacturer, the output of airplanes can be materially increased.

Knowing that the final success of our efforts in the war depends upon our overwhelming ascendancy in the air, we must not neglect anything in putting forth the very best that is in us—as we would do if the enemy was hammering at our shores—to get the aircraft program under way.

We must and we will succeed this time.

ANTHONY STADLMAN.

(Copy of Letter to Aircraft Board)

For the past twelve months and during the time when the necessity of speeding up of aircraft production was most urgent and imperative, we were offering our services as manufacturers of aircraft to the Aircraft Board, anxious to cooperate in the production of aircraft and willing to place our organization, manufacturing facilities and our long experience in airplane construction at the disposal of the government.

After numerous trips to Washington and our interviews with the officers in charge of the production division of Aircraft Board, it became quite apparent to us that it was absolutely impossible for us to receive due consideration and recognition and no matter how loyal and sincere we were in our intentions; that we did not have the remotest chance to secure even a small order for airplanes that were and will be needed so badly for our army.

All our efforts to prove, that our long experience in the art of airplane construction and designing was a guarantee of our ability to make good in the production of airplanes and that we did not need to be educated in this new art, as some of the firms that secured large contracts for aircraft in spite of the fact that they never had any practical experience in airplane construction, or the remotest knowledge of aeronautics in general—failed and we could not help but feel that we have been purposely slighted at a time when it was clearly apparent that the aircraft program was falling rapidly behind the schedule and when it was really imperative to take advantage of all the aircraft manufacturing resources, especially those that possessed practical experience and knowledge, and could have been of potential value to the government at the present time.

We can not understand why we were not given an opportunity to assist in speeding up of aircraft production and why our manufacturing facilities even though they were comparatively small were not secured to increase the output of as much needed aerial equipment when orders were being placed with foreign manufacturers for great numbers of machines, as disclosed in the investigation of the aircraft situation, and when the furniture manufacturing companies of this city, although they never had any practical experience in aircraft manufacturing nor the organization of experienced men to take care of this work to start with, were given large contracts for Bristol scouts and huge and complicated Handley-Page machines.

We can realize the great difficulties which have had to be faced in building up an aircraft industry in this country and in securing production, and we know that eventually manufacturers who were never connected in any way with aircraft production, would have to be initiated and educated for this essential work, but we maintain that the concerns with experience and ability were entitled to first consideration and that unnecessary confusions, delays and expenses that were bound to develop with inexperienced firms could have been avoided and far better results secured.

Placing orders with foreign firms for immense numbers of airplanes while so many of small aircraft firms in this country were on the verge of closing their doors after several years of hard struggle for their existence was another harmful blow to the development of aircraft industry in this country, and it will make it so much more difficult for us to keep up with the foreign competition after the war when the commercial future of airplane is established. Leading men of this country and foreign countries are convinced of immediate commercial future of airplanes after the war and we must try to establish our prestige in this commercial development while we have the chance to build up an aircraft industry by placing initial orders with firms that have had the necessary experience and eventually would develop into potential factors in the American industry.

The present situation and the fact that a still greater expansion in the aerial program was recently decided upon by the government prompts us to send this letter to you with hope that it will draw proper attention and secure due recognition to a number of small aircraft manufacturing companies in this country.

We wish to state that we have endeavored to keep our organization together under very adverse conditions and in spite of discouragements, and that to-day we are just as

anxious to cooperate in the production of aircraft as we were a year ago. It is very essential that we know whether or not our services, which we will proudly render, could be of any value to the government.

Any information that may be required in regard to our manufacturing facilities, personnel and experience can be secured at the Office of Lieut Lohman, Bureau of Construction and Repair Navy Department, Washington, D. C.

MICHIGAN AIRCRAFT CO.
ANTHONY STADLMAN

June 1, 1918

The Motometer Co., Inc.

In a letter on the aircraft production situation, it is quite evident that it will be impossible to be both diplomatic and constructive in one breath.

We believe that constructive suggestions are really what are required, and hence, we offer the following as taken from a long list of troubles which we have experienced in obtaining practical specifications, adequate instructions as to inspection, equipment, deliveries, etc.

Let us start out by saying that we have been much pleased to notice a marked lessening in the amount of red tape involved in securing and executing contracts, within the past four months, and that, we believe these improvements will continue in the right direction from now on. First, we should like to see a closer co-operation between the bodies of men who draw specifications, issue contracts and do the inspecting, located at Washington, and the men who install accessories at the factories, do the testing and conduct test flights, and the aviators themselves who have to use the product.

We feel that the men in Washington in charge of the above, do not spend enough time in the field talking to the second class of men mentioned, whose practical first hand knowledge of which is wanted and which is so essential to efficient readjustment of already drawn specifications, or the intelligent writing of shipping orders, or a practical mode of inspection.

We suggest that it be made possible for the all too busy heads of these departments to get out into the field for the purpose of becoming more intimately acquainted with the practical conditions, so that their view of what is required by the fliers and what conditions must be fulfilled may be much broadened by the opinion of those who must actually use the product which they order. By this method, and this method only, does the manufacturer acquire an intimate knowledge of the requirements of his customers. A system of building his product along lines which do not satisfy the customers' demands or which do not operate efficiently under the conditions for which it is intended, would, in a very short time, ruin his business entirely. Let our Government apply these methods to its business of supplying the aviators with aircraft accessories.

Our second suggestion comes as a direct outgrowth of our first. We, as manufacturers, are pursuing our every day practice of following up our product by sending engineers to the fields and factories where our instruments are being installed and used, for the express purpose of ascertaining the faults which our instruments may possess, or for the purpose of at least separating the good and desirable qualities of our product from the features which are undesirable. In the course of these trips and by means of many interviews with those who use our product, we are constantly informed as to the true performance of it. We are frankly told where it can be bettered. These suggestions we endeavor to incorporate in new designs for the purpose of delivering an instrument of higher quality. This information, compiled with our many years of practical experience in our own line, we believe, puts us in a better position to judge as to just how our product should be built than is possible for any one else to know.

We have tried to hold ourselves equally receptive to suggestions from Washington as to changes "behaved desirable" there, and have been only too eager to make suggested changes from no matter what source they have been given. These changes have often proved of little value later, and much valuable time has been lost by holding up production for these changes.

We, therefore, enter here a plea for more leeway to the manufacturer, in order that he may deliver his best, unhampered by the possible wording of a set of specifications which may be correct in judgment as to dimensions, weight, etc., but which dictate actual ways of manufacture, dimensions of parts, etc., which cannot be changed except through a long series of delays and arguments, which sometimes result in a negative decision. Cannot our Government place more reliance in the men who are supposed to know their particular line best?

Our third and last request is that when contracts are awarded, we believe much time can be saved by furnishing all possible instructions with them. At present, we are awarded a contract for a large number of instruments all alike in certain details, yet radically different in others. In the course of time, definite instructions, as to what quantities of which type, are forthcoming, and an account of having received the total contract some weeks before, we are expected to start deliveries on receipt of these instructions. As a matter of fact, these instructions may be absolutely necessary in order to start manufacture on this particular type.

In short, let all available data be furnished the manufacturer at the time the contract is let. Thus, we feel sure, will hasten deliveries.

All of the above we offer in a constructive spirit of co-operation with our Government, with the hope that it may aid in improving the situation which, we are convinced, is steadily becoming better.

R. P. NICHOLS.

Mott Wheel Works

At the present time we are doing a great deal of Government work and have a large capacity open for the manufacture of airplane wheels and rims. We could without question of a doubt produce in the neighborhood of 300 complete wheels per day, as we have a large amount of material and machinery especially for handling this class of work.

Anything you can do for us in regard to securing contracts along this line will be greatly appreciated.

JAMES N. HOUSE
Sales Manager

Scientific Aeroplane Co.

I would like to call attention to the importance of experimental work and to the sad neglect of this at the present time, almost as much as in the past.

Germany merely improves what we originate. Her two greatest weapons—the submarine and the airplane—were the product of *our* inventive genius. There are other forms of flying machines, such as the helicopter, that are highly desirable and very much wanted, yet little or nothing has been done toward setting our inventors at work to perfect them.

Instead of the Government being eager to grab inventions, they refer all experimenters to the National Advisory Committee for Aeronautics, with the same result as the writer encountered when he asked Mr. Coffin to give an order for one each of three types of an improved airplane to be used for three different purposes—a polite letter stating he was unable to give any such order, as he was Chairman of the Aircraft Board in an *advisory* capacity only, and could place no orders no matter how fine the article or how much needed.

The Germans are said to have fallen behind as regards engines owing to their sticking largely to the old Mercedes design. Yet even *they* have not "put all their eggs in one basket," for they have in reality four to six different types and makes. In England there are 61 different types, as a result of which great progress has been made. The A. B. C. air-cooled radial motor is about the last word as regards a light, high-powered, multiple-cylindered engine. England has fully a half dozen types that can be depended upon and that are up-to-date. I hope it is true that our policy has been changed and that we too are to develop different types and makes of motors.

Far better that we give our own inventors a chance—if they have something already developed—than that we import foreign motors and try to produce them in quantity as we have been doing of late, and as was our policy a year ago with the airplanes themselves, and as today with certain Italian bombing machines. How ridiculous and what a waste of time and effort that Italy should send a Caproni triplane here to fly across the Atlantic. Did we not build in this country the first large triplane and *ship* it to England? It had a spread of 131 ft., and has only lately been surpassed by the 141-ft. spread Gotha biplanes with four 300 hp. motors. Why do we not originate and build machines similar to the Golhas and fly them across from Newfoundland to Ireland—an 1800-mile trip—in 18 or 20 hours? Bombing Berlin would be easy with such machines carrying 10,000 lb. of bombs. Equipped with four Liberty motors, such a machine could surely keep aloft for 24 hours.

Every aviator and observer should have a safety parachute, the same as does an observation balloon man, and thus be given a chance for his life. Raoul Lufberry would probably be alive today if he had had such a device. He deliberately jumped from his machine rather than be incinerated. The prevention of fire from backfire—the chief cause of the burning of machines other than fighters in mid air—is now an accomplished fact by means of a certain device. Every engine should be equipped with it. The above are two safety devices that should be universally employed. Let us hope the day will soon arrive when Uncle Sam will have in use all the latest inventions, for it is Yankee inventiveness that the Huns fear most of all.

STANLEY YALE BEACH

Scovill Manufacturing Co.

Our facilities are almost entirely occupied by direct and indirect Government work, very little of which is applicable to airplanes.

E. S. SANDERSON

Segul Aeroplane Co.

We are not trying to do contract work because the experimental stage has just been passed and are now building the large machine which has many new and modern features—a new departure in airplanes.

We have been sufficiently encouraged in experimental work but we are not capable at the present time to handle a quantity of additional orders, but we would be willing to help the greater production of machines.

E. N. HENZEN

B. F. Sturtevant Co.

I am inclined to think that it would be just as well to sit quiet and say nothing at this time. It is easy enough to criticize the past or the present, but I do not think anything is gained thereby. The damage that has been done to the whole aircraft industry is a highly serious thing, and has delayed production weeks, if not months, in time.

These various investigations have also brought out all the recommendations which I could make and I feel sure that I could add nothing to the general program.

BENJ. S. FOSS

Palmer-Simpson Corp.

We are at present, as you know, subcontractors on aircraft work for the Navy and as the public interest is centered in the Army, little attention is usually given us.

In business a year and a half, we have found little trouble in getting such contracts as our immediate facilities would warrant. We have greatly increased our facilities and have at present a large shop at Plattsburgh, N. Y., which is entirely idle. Our own trouble with contracts is the lapse of time between the ending of one and the beginning of the next, which in a specialty like ours means laying off the men and trusting to luck to be able to pick them up again in two or three weeks or a month. There are many men who finish their work long before the contract is completed and it should be possible to start them on parts for a new job immediately. This would hasten production by several months, but so far has been impossible.

For the production or inspection department of the Navy we have nothing but the highest praise. "Red Tape" is conspicuously absent and the spirit of cooperation and helpfulness from top to bottom is very gratifying.

Delays in receipt of drawings and specifications and changes after they are received are, of course, vexatious but probably necessary in the present stage of the art. Even this condition has vastly improved and drawings now are apparently meant to be built to.

We are, fortunately or unfortunately, considered a producing firm and our tentative efforts at experiment have been pretty generally frowned upon. Whether this is right or wrong I cannot say, however, we are turning out the stuff, which is what the Navy wants.

As the supply of practically everything one wishes to buy has been "taken over" by the Government, nearly all materials, while easy to order and glibly promised, are very difficult to obtain. It would seem possible to supply all recognized manufacturers and jobbers with a list of preferred buyers and their contract numbers and thereby kill a great deal of delay.

Of the financial question we can talk on both sides. We have wanted a long time for our money and we have received it in five days. We have received advances for equipment and again we have been refused.

We have had little experience with cost plus contracts, just enough to convince us that the straight price method is far preferable. It permits of bonus work on the shop and we believe turns out work faster than the cost plus system with the best of intentions.

As to ourselves and our facilities, in an organization of over a hundred men, we have not one subject to the draft. We have a crew of skillful men, most of whom have been trained in this particular work for a year or more. We are and have been from the start willing to do anything which the Government asks. We have unused plant facilities to the extent of more than twice our present output and are prepared to start on new work in two weeks' time.

DWIGHT S. SIMPSON,
President.

Experiences of an Airplane Manufacturer

After repeated attempts and frequent trips to Washington, D. C., in an effort to get the proper Government officials to place an order with our firm for aircraft, or parts, in fact, anything, so that we could get our plant running on a production basis, and after numerous promises the writer was finally sent by one of the Government officials to inspect the production methods of two of the leading aircraft factories. In one of these plants they were not entirely equipped, therefore there was no production to be inspected, yet they had an order for quite a number of training planes.

The object of this inspection was to familiarize the writer with production methods in these plants so that our firm could handle the work expeditiously in the event of our being awarded a contract, which the writer had been promised upon his return to Washington, and which was made immediately after visiting the aforementioned plants. However, on my return to Washington, after spending considerable time and money, I was politely informed that their program had been changed, and that they could not give us the contract which had been promised before my visit to the plants.

After this fiasco at an attempt to obtain a contract, we decided that it was hopeless, and gave up the "Ghost," awaiting patiently the time when conditions in Washington would change.

All of these difficulties were encountered in spite of the fact that we had a fully equipped, modern, up-to-date plant, built for the sole purpose of manufacturing airplanes, and not an antiquated, obsolete type of woodworking plant which came into general favor as sub-contractors. Our plant had been inspected by a Government inspector and passed on very favorably. Our active head is a man of eight years' experience, both theoretical and practical, in aeronautics.

Had we been given the proper encouragement at Washington by their placing with our firm some kind of an order, we could have by this time increased our production 200 per cent, instead of being in the same position now that we were over a year ago.

From our experience we candidly believe that a plant to get maximum production should confine its efforts solely to one type of plane, if building complete machines, or if building parts to ent these down to the minimum and make the quantity specified sufficiently large to insure at least six months' operation of the plant at its maximum production. A small plant, working on parts, cannot be expected to become an efficient organization with only a small order and the prospects of securing additional business very remote. In our opinion, the business should be divided up, for under the present system some of the plants are hogging it all, while we are compelled to be content with a very small sub-contract not

requiring more than one-tenth of our maximum facilities.

Experimental work in this country has been kept at a minimum, and especially so for a nation the importance of ours and possessing the ingenuity that this country has shown in all lines of invention, by all means there should be an appropriation made for experimental work on aircraft, for no doubt there is much latent talent awaiting the opportunity to show the world at large something new.

This letter is not intended to be one of criticism, but the facts are stated with the hopes that this letter, along with others, may have the desired effect of inaugurating a change in the present aircraft program, whereby all manufacturers who are equipped or capable of producing aircraft or parts—in this we refer particularly to some people who have been in the business for years and have been unable to obtain any recognition whatsoever—will be able to get an order of some kind, and thereby be instrumental in furthering our great aircraft program.

Whittemore-Hamm Co.

It is our frank opinion that much harm is being done aeronautical enterprises by the present ruling preventing civilian flying. We believe that private schools should be encouraged, that passengers should be carried, and that general exhibition work stimulates public attention and creates enthusiasm for aeronautical development.

Since the earliest days of flying, aircraft producers have been absolutely dependent upon exhibition flights, passenger carrying and pupils. Without the revenue from these sources all American constructors would have found it impossible to have continued their experimenting and the United States would not have had the few small concerns that were in existence at the outbreak of the European war which through foreign orders grew, and upon our entrance into the war became the sources of America's airplane and engine supply.

We believe civilian flying should be allowed under the following conditions:

1. License certain civilian pilots to fly over designated fields in specified machines, said machines to bear identification marks. Designated fields apply to areas so situated that no information of value to the enemy could be obtained or where no military damage could be done.
2. Allow such licensed pilots to carry pupils or passengers over such designated fields.
3. Allow such licensed pilots without passengers to make cross country flights only upon special permit for each flight made. Special permit to be obtained from the Joint Army and Navy Board on Aeronautical Cognizance.
4. Civilian machines must not carry wireless, machine guns, or cameras.
5. Designated fields to be approved by the Air Service Department.
6. Pilots to be approved by the Air Service Department.

Williams Steel Wheel & Rim Co., Inc.

In the matter of the contracts for airplane parts, at the present time, we are doing practically nothing in the airplane line. We have about 12,000 sq. ft. of floor space which we can adapt to the making of rims or complete wheels—in both of which lines we have had long experience—should any one care to take advantage of what we have to offer.

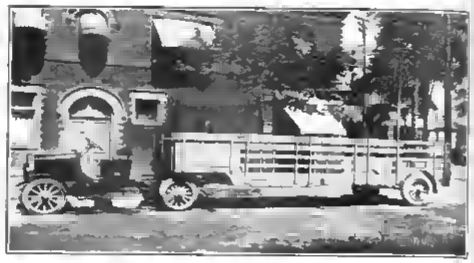
D. H. Wetzel,
Sales Manager.

Motor Trailer for Airplanes

A novel type of motor trailer for airplanes, which has just been put on the market, should prove a valuable addition to the equipment of flying fields. This trailer, developed by the Fruehauf Trailer Co. of Detroit, Mich., operates in conjunction with a special light type tractor truck, produced by the Acason Motor Truck Co. of the same city, and permits to take on board a complete airplane by running it up on skids, and then haul it on the road at a goodly rate of speed to its destination.

The practise of hauling airplanes on the road is coming into use in certain sections of the country where it is desired to move machines without using their own power. In the case of disabled airplanes it proves handy to move the entire machine without dismantling it from wherever it may be to the repair shop so it may be given proper attention.

The trailer is 25 feet long, 7 feet wide, with racks 48 inches high. It is equipped with 38x7 Goodyear all weather tires on



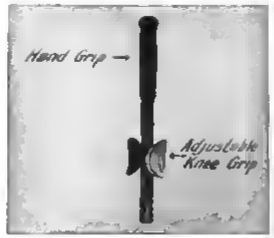
Tractor and Trailer Complete.

the trailer and solid Goodyears on the Acason Motor Truck Company's light type tractor. The trailer has a capacity of three tons. Its development is the result of French war experience.

It is believed that the combination will prove of much value in the commercialized aeroplane activity which is planned for the after war period. It has caused favorable comment among prospective commercial airplane builders in Detroit, which city is looking forward to being one of the big airplane manufacturing centers at the conclusion of the war.

Warner Duplex Control Column

This stick control column is the invention of William Deshler Warner, 8 East Broad Street, Columbus, Ohio. It exercises the same functions in operating the control surfaces as other controls with the usual hand grip at the top. The particular advantage of the Warner control is an adjustable grip for the knees, which is easily adjusted while in flight to fit any size pilot. This installation makes the controlling of the plane with the legs a positive function instead of a haphazard makeshift.



The knee grip is an aluminum device shaped to fit the contour of the legs on either side, and vertical ribs to prevent forward or backward slipping, and so formed at the rear that if the column is pulled hard for an extreme climb it is not in the way of the pilot.

With the Warner control several pilots have been able to execute consecutive figure eights without touching the hands to the control, and flights up to 30 minutes' duration have frequently been made where the machines were operated entirely with the knees and feet.

Book Review

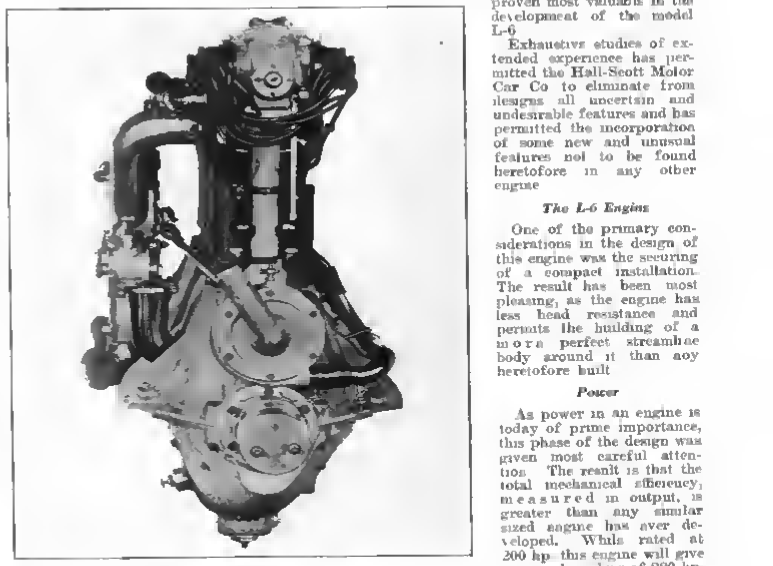
Glorious Exploits of the Air. By Edgar Middleton. D. Appleton & Co., New York and London. ($1.35. 256 pp., 4 plates.)

This book, written by a former Flight Sub-Lieutenant of the Royal Naval Air Service, describes in a vivid style the routine work and exploits of Great Britain's military and naval aviators and makes as such interesting reading for the non initiated

The Hall-Scott 6-Cylinder 200 hp. Airplane Engine

The success of the 6-cylinder 200 h.p. Hall-Scott airplane engine—the latest production of the pioneer aero-engine builders of San Francisco, Cal.—calls not only for a description of this remarkable American product but also for recognition of the progress made by this firm during ten years of airplane engine building.

The design of this engine—the model L-6—is not new but rather the result of ten years of progressive development. Since 1914 the Hall-Scott Motor Car Co. has been building six cylinder vertical engines of the A5 and A5-a models. The experience gained in checking results obtained on the test block and under actual flying conditions through quantity production under United States and foreign Government inspection has made possible the production of a fighting job in this new L-6 which will equal, if not surpass, airplane engines of other types and designs, either domestic or foreign.



End View, Hall-Scott Model L-6 Engine.

The model L-6 is a 6 cylinder vertical engine, which develops 200 hp. and weighs less than 500 lbs., it is 165 lbs. lighter and gives 50 hp. more than the A5 or A5-a models.

The L-6 is a simple engine, for the efficient engine of to-day must be the epitome of simplicity—an engine of no complicated designs or debeatable elements—one that insures the maximum ruggedness to withstand the severe conditions imposed by the fortunes of war.

An airplane engine cannot receive the careful nursings of an expert engineer, it must function properly when taken care of by mechanics whose only training perhaps has been that received by Government instruction covering a limited period of time. This means that an engine having the factory and the watchful eye of experts must function and perform under adverse conditions.

The necessities of war have brought about a condition whereby men of little or no previous mechanical training must operate engines, over haul them, tear them down and rebuild them, must make them run at sea level or 10,000 feet in the air, in summer or winter, wind or snow, rain or shine, night or day, over ocean or desert—exposed to every destructive force and element of nature.

A successful airplane engine must be designed for easy installation in planes of many designs—schooling, scouting, bombing and fighting planes—installed so as to be not only accessible to itself but to its control.

The prime essential of an airplane engine is strength. It must be so constructed that all moving parts have factors of safety far in excess of automobile engine types for an airplane engine must not only be strong enough to withstand the stresses generated within itself, but strong enough to withstand and resist continuous running often with wide-open throttle for full power delivery.

The concrete crystallization of a design into a successful airplane engine is not, therefore, a simple problem. It is most complex—a problem in which all of the afore-mentioned factors and many more must be co-ordinated into a plane of logical sequence based on accurate knowledge and experience.

Since the first airplane engine was designed and built by E. J. Hall in 1908, many engines of various types have been produced for use in the United States and abroad. The knowledge and experience gained through the actual use of these engines in every part of this country, in the Philippines, in Japan, in Russia, in Java, in the Netherlands and in other countries, the compilation of data that has proven most valuable in the development of the model L-6.

Exhaustive studies of extended experience has permitted the Hall-Scott Motor Car Co. to eliminate from designs all uncertain and undesirable features and has permitted the incorporation of some new and unusual features not to be found heretofore in any other engine.

The L-6 Engine.

One of the primary considerations in the design of this engine was the securing of a compact installation. The result has been most pleasing, as the engine has less head resistance and permits the building of a more perfect streamline body around it than any heretofore built.

Power.

As power in an engine is today of prime importance, this phase of the design was given most careful attention. The result is that the total mechanical efficiency, measured in output, is greater than any similar sized engine has ever developed. While rated at 200 hp. this engine will give a normal reading of 220 hp. at 1750 r.p.m. This result has been achieved by careful consideration of fuel distribution, valve action, and the factors governing thermal efficiency, reciprocating parts in relation to engine speed, etc.

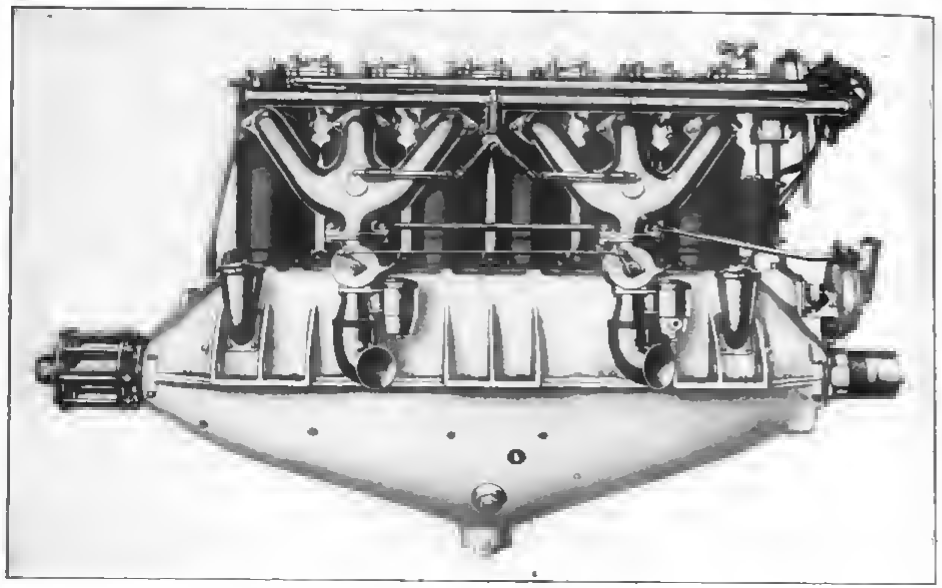
Fuel and Oil Economy.

To obtain maximum cruising radius with minimum weight the fuel problem was given careful consideration. Continuous experiments have shown a fuel consumption not greater than .55 lbs. of gasoline per b.hp. hour, with an oil consumption of less than one-half gallon per hour.

The arrangement of the valve, the diameter and lift and effective opening and the design of the manifold for the distribution of fuel, with specially designed carburetors, are all conducive to a high volumetric efficiency.

The construction of the cylinders, the method of jacketing, the circulation of the water induced by circulating pump but taking advantage of natural thermo-syphon principle, with due consideration to expansion factors, the piston design, clearance and heat radiation permits the highest possible thermal efficiency.

Observations on the field have demonstrated that carburetor adjustments are the cause of considerable troubles to flyers. Inexperienced field mechanics adjust carburetors so that too lean a mixture oxidizes the valve stems and burns out the seat,



SIDE VIEW OF THE HALL-SCOTT MODEL L-6 ENGINE

ar a too rich mixture causes the engine to overheat and quite often flare-backs from pre-ignition

To obviate and partially overcome these troubles, the range of water temperature has been made as great as possible, permitting the temperature to rise from normal of 160 degrees to as high as 200 degrees without injury to the engine

The valves used in the L-6 are the same as used and found to be satisfactory, in previous 6-cylinder engines

The carburetors are so arranged that danger of fire from flooding or flare-back can be eliminated

Modern warfare demands many stunts of the flyer, such as nose and tail spins, looping, etc., and in many old style engines much trouble was caused by oil getting into the cylinders, fouling the spark plugs and causing mis-firing, as well as oil escaping and blowing into the face of the operator when the equilibrium of the engine was disturbed. These things have all been carefully considered in the L-6 with the result that this is as near an oil-tight motor as can be produced

The oiling system has been devised utilizing a pump with a double lead so that in addition to distributing oil to the working parts of the engine, auxiliary oil tanks can readily be connected in case flights of long duration are necessary

As the temperature, climatic conditions, differences in viscosity and gravity of the different lubricating oils bear a relation to oil pressure and feed, external oil relief valves have been designed that cover a range of pressure to 35 lb per sq in A large capacity by-pass automatically operates at any set pressure which may be pre-determined by the operator to meet existing conditions.

Weight

Each element entering into the construction has been closely checked and analyzed so that each part can be made as light as possible yet maintain the highest stress factors The weight of this engine is less than 2½ lb per b hp

Ignition

While the model L-6 can be built to utilize any standard ignition system, experimental and first allotment of engines now under production have been fitted with the Delco system. This battery ignition has the following features.

1 **Reliability** Two distinct distributor mechanisms, each one igniting all six cylinders through separate spark plugs Each distributor head is fitted with two sets of breaker arms and contact points Two distinct sources of electrical energy—battery and generator—are available

2. **Safety**. The auxiliary breakers prevent the possibility of a back kick

3 **Great range of spark timing control** A spark of the same intensity is produced whether advanced or retarded through 360 deg

4 **Easy starting** A spark of the same intensity is produced at cranking speed as well as at flying speed

5 **Ability of pilot to tell whether the electric equipment is functioning properly through the medium of the ammeter**

6 **Distributor** heads are driven direct from the camshaft through a worm gear

7 **Long life** The distributor heads run at a slow speed (one half crank shaft speed)- hence the wear is slight

Conclusion

The general characteristics of the L-6 are as follows:

No of cylinders	6	Propeller Dia	8' 0" (Average
Bore	5 in	Pitch	6' 0" (
Stroke	7 in	Carburetor	Miller
Rated horsepower	200	Cooling Water—Centrifugal pump	
Normal R HP	210	Ignition	Delco Battery
Speed	1,700 r p m		

Piston displacement 824.570 cu in (1137.445 cu in per cylinder)
Piston speed at normal r p m (1700) 1983 feet per minute
Compression volume 24.74 C cu in.
Weight of engine dry including carburetors ignition system and propeller hub 500 lb.
Weight dry per normal hp 2.05 lb.
Water temperature inlet 140 deg Fahr
Water temperature outlet 160 deg Fahr
Water circulation 18.5 gal per min.

The Clement-Bayard Rigid Airship

It is a little known fact that, though the rigid airship has been chiefly developed in Germany, particularly through the efforts of the Zeppelin and Schutte-Lanz concerns, the basic elements of this type of aircraft were first patented in 1873 by a French engineer, Joseph Spiess, a native son of Alsace

However, the airship in general, and the rigid type in particular, never enjoyed a great deal of popularity in France, where the future of aerial navigation was always considered to be dependent on the success of the airplane, and consequently French airship designers and builders received little official encouragement in spite of the fact that some very promising types have been developed in that country.

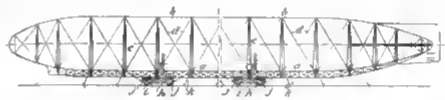


FIG 1

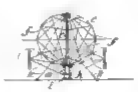


FIG. 2

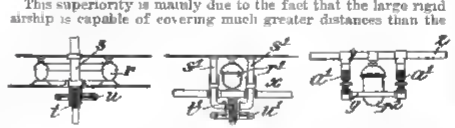
Spiess himself, the father of the rigid airship, succeeded in having his design officially accepted only in 1909, after the disaster of the *Republique*, when he offered to cover the expenses of a rigid airship which was to have been built to his designs. This craft, the first French rigid airship, was actually built, and reached completion in the spring of 1913, at a time when the world's distance and duration records for airships had in a spectacular way been carried off by Germany's Zeppelin airships

While it is true that the large airship of the rigid type has not proven all that the Germans expected from it, and has,

FIG 3

in particular, signally failed as an offensive weapon, it is nevertheless recognized today in naval circles as affording an exceedingly valuable means for long range naval reconnaissance in which function it is still very much superior to the large flying boat

This superiority is mainly due to the fact that the large rigid airship is capable of covering much greater distances than the



FIGS. 4, 5, AND 6

seaplane, and also, because it can stay aloft regardless of engine failure, and can vary its speed so as to keep station with a fleet at sea.

Since the war began Great Britain is understood to have built several experimental rigid airships, and Japan as well as this country have been reported to have perfected plans for building such craft; on the other hand, Germany has never entirely ceased developing its Zeppelin and Schütte Lanz airships, although, instead of employing them for offensive purposes, their use has of late been restricted chiefly to naval reconnaissance

In view of the above considerations considerable interest may be elicited by the specification of letters patent issued by the United States Patent Office on May 7, 1918, to Adolphe Clément-Bayard, of Levallois-Perret (Seine), France, covering a new system of construction for rigid airships. M. Clément-Bayard is well known as the constructor of the non-rigid airships bearing his name, several of which, manned by French Army crews, performed satisfactorily in the early part of the war.

The specifications of the letters patent (No 1,265,302) read as follows:

The present invention has for its object a dirigible of the rigid type, the girder of which is constituted in such a manner that it will withstand the strains due to its own weight when it rests upon two supports conveniently located at two points in its length. In combination with these conditions, it also relates to the employment of special devices for the deflation of the gas ballonnets, means for rapidly removing the outer envelope from the girder, of laterally guying the girder throughout its entire length, and if necessary for preserving one or two inflated ballonnets to contribute to maintaining the girder in its normal vertical position. The whole thus constituted has been established and combined in such a manner that it is possible in case a storm should break when the airship is resting unprotected on the ground, to protect it from the effect of wind capable of breaking it or of tearing it from its moorings.

FIG. 7

Figure 1 is a side elevation of my improved girder;

Fig. 2 is a cross-section thereof;

Fig. 3 is a plan view of the communication passage,

Figs. 4 and 5 are detailed views of shock absorbers interposed between the car and the girder,

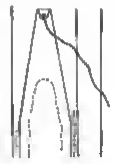


FIG. 8

Fig 6 is a detailed view of a shock absorber interposed between the car and the ground;

Figs. 7 and 8 represent a tearing bar in side and front elevation respectively,

Figs. 9 and 10 are elevational and plan views respectively of portions of a dirigible, and details of tearing mechanism operable from the platform;

Figs. 11 and 12 are views showing a cross-section and an elevation of a portion of a dirigible and details of the tearing mechanism operable from the ground,

Fig. 13 is a diagrammatic view showing another form of tearing mechanism,

Fig. 14 is a diagram of a form of tearing lasing;

Figs. 15 and 16 are cross-sectional and elevational details respectively of drums for winding and unwinding the bands; and

Figs. 17 and 18 are cross-sectional and elevational views respectively of deflating mechanism for the ballonnets.

When a girder rests upon two supports, strains are produced in its various elements (uprights, diagonals, upper framework and lower framework), these are either compression or tension strains and their value is well determined. The girder generally comprises elements whose constitution cannot be determined solely by the conditions of resistance, certain conditions necessitated by its employment should also be considered. It will be understood that it may comprise elements which, owing to the dimensions of their section, would be particularly suitable for withstanding compression strains and that consequently it would be desirable, with a view to the minimum weight of the whole, to concentrate the said compression strains upon these elements; in this case the tension strains are reserved for the elements of reduced cross-section.

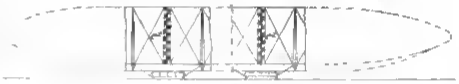


FIG. 9

Thus is the case with the girder for rigid dirigibles forming the object of the present invention, and which is represented in side elevation in Fig. 1 and in cross-section in Fig. 2. This girder is constituted in the following manner:

The lower framework by the communication passage *a* extending throughout its entire length and represented in plan in Fig 3.

The upper framework by light beams *b*.

The uprights by vertical pylons *c* located in the median plane.

The diagonals by wires or cables *d* and finally, the transverse

rings located in the plane of the uprights by framework members, preferably tubes *e*, connected together and braced by a triangle system of wires *f*, the wires being under tension and assuring the non-deformation of the external contour of the

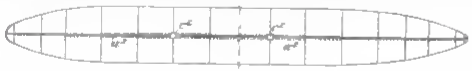


FIG. 10

rings. The ballonnets are located between these rings and the outer envelope preferably incases the ballonnets and the framework of the girder, including the ring constituting elements.

When it is desired that a girder complying with this descrip-

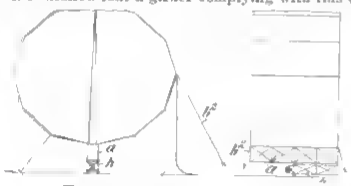


FIG. 11

FIG. 12

tion and whose ballonnets are deflated should be able to rest upon any unleveled piece of ground upon which it might only be supported at two points, practically speaking, considerable strains arise. The present invention consists in particular in assigning as positions for the two points of support, places which will localize the compression strains in the lower framework or communication passage.

In order to attain this result the following arrangements, which are given by way of example, may be adopted.

Two cars A containing the motor mechanisms are utilized for the points of support. These cars are of course designed to withstand particular strains, they are provided with an appropriate supporting surface at the upper part upon which the girder rests.

The girder should be capable of withstanding strains due, to its own weight, to the weight of the envelopes of the ballonnets, to the weight of the fuel and of the ballast before it is discharged, to the weight of the outer envelope, if, after it has been torn, it remains folded or rolled, to the weight of the empennage and of the rudders mounted at the rear, to the weight of the navigation and observation cabin located at the front extremity of the passage.

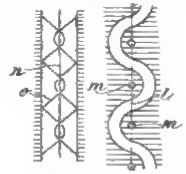


FIG. 13

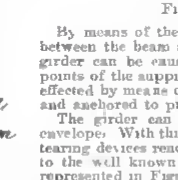


FIG. 14

As will be understood, it is possible to arrange the supporting cars in such a manner that the upper framework is exposed to tension strains only, the lower framework or passageway supporting the compression strains. This is an essential feature of the present invention and, to use mechanical terms, it may be said that the moments of flexure from one end of the girder to the other would then have the same sign, of course with two maxima, plumb with the supports.

Given these conditions, if on landing it be desired to protect the airship from a threatened storm, this method is adopted.

The pneumatic shock absorbers or other landing devices are put out of action so that the cars rest directly upon the ground. The pneumatic shock absorbers are constructed in some suitable manner, three forms being indicated in section in Figs. 4, 5 and 6. Figs. 4 and 5 relate to two constructional forms of shock absorber *j* (Fig. 1) interposed between the car and the girder and Fig. 6 relates to a form of the shock absorbers *i* interposed between the car and the ground.

In the arrangement illustrated in Fig. 4, the absorber is constituted by a pneumatic ring *r* interposed between the bottom of the girder and the car and traversed by a rod *s* integral with the girder, this rod serves to eliminate the action of the shock absorber in the condition of repose, by bringing into contact with it the threaded rod integral with the car, in causing it to rotate by means of the handwheel *u* until the lower end of the rod *s* bears against the top of the said threaded rod.

In the modification illustrated in Fig. 5 a pneumatic ball *r'* is interposed between the girder and the car; in acting by means of the hand wheel *u'* which is screwed onto the threaded

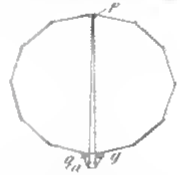


FIG. 15

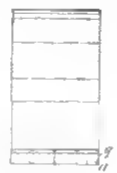


FIG. 16

rod *t'* the fork *x* is caused to rise and fall in order to bring it into contact with the two *rods s'* fixed beneath the girder.

In the arrangement illustrated in Fig. 6 which relates to the shock absorber arranged at the bottom of the car, the pneumatic cushion *r'* is surrounded by a frame *y* which is lowered by means of oppositely threaded screws *a'* to bring it into contact with the ground in such a manner that by rotating the screws *a'* the pneumatic cushion may be relieved of the weight of the girder, while the airship is at rest.

FIG. 17

FIG. 18

By means of these devices, the shock absorbers *j* interposed between the beam and the cars are put out of action and the girder can be caused to bear directly upon the appropriate points of the support. Guying such as shown in Fig. 2 is then effected by means of cables *k* fixed on either side of the girder and anchored to piles driven into the ground.

The girder can then, if desired, be freed from its outer envelope. With this object in view the envelope is provided with tearing devices ready for use. These devices may be analogous to the well known tearing bar of spherical balloons and are represented in Figs. 7 and 8, arranged along the top and sides of the cylinder. Cords *a'* and *b'* attached in advance and adapted to be operated from the top of the dirigible and from the ground respectively, effect the tearing as indicated in Figs. 9, 10, 11 and 12. Funnels provided with stairways *c'* afford access to the top side for actuating the cords *a'*. When the panels of fabric have been released, the cords fixed to the upper generatrix of each half panel are pulled for the purpose of bringing the fabric to the ground and turning it over. It will of course be understood that the tearing devices above referred to may be replaced by other devices, such for example as that represented in Fig. 13 which consists of passing a lace *l* alternately through the eyelets *m* provided on the edges of the adjacent panels, this lace can be withdrawn by exerting pulling upon one of its ends. Another method consists of laces *s* sliding in loops *o* (Fig. 14).

Instead of bringing the half panels to the ground, drums *p* and *q*, represented in Figs. 15 and 16, may be employed in the manner adopted for certain kinds of blinds, these drums permit of winding or unwinding and in the latter case the outer envelope remains upon the girder when rolled or folded.

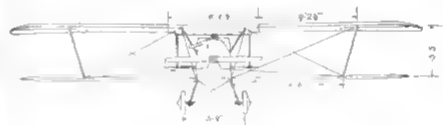
Finally, the ballonnets are deflated in some suitable manner, for instance by means of a tearing bar *v* as shown in Figs. 17 and 18. One or two of these ballonnets may remain inflated to assist in maintaining the girder in the normal vertical position if necessary, and compatible with the velocity of the wind.

Digest of the Foreign Aeronautical Press

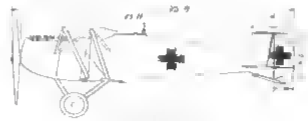
Flying (London), June 5, 1918

The Hannover Biplane—The machine illustrated by the accompanying drawings was captured practically intact and belongs to the C class of general utility machines. It is of comparatively recent manufacture, as several parts were stamped with the date 19/12/17.

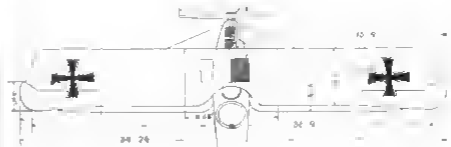
The span of the top plane is 39 ft. 2½ in., this being made up of a center section of 8 ft., 6¾ in. and two outer sections.



FRONT ELEVATION



SIDE ELEVATION



PLAN

In the center section is housed on the right-hand side the radiator, conforming to the wing curve, as in most recent German machines, and on the left-hand side a gravity gasoline tank of 33 liters capacity. To the under surface of the center section is fitted a radiator shutter, circular in form, and operated by a knob attached to its periphery. The chord of the top plane is 5 ft. 11 in., and the length of the balanced ailerons, fitted to the top plane only, is 7 ft., 8 in. A notable point in connection with the ailerons is that the levers or cranks are attached to the innermost end, the efficiency of this arrangement being open to very great doubt.

The lower plane differs in every way from the top, being of smaller span, this from lip to tip being 36 ft., 9 in., with a chord of 4 ft., 3¼ in., while the camber of the under surface of the wing section is almost flat compared with that of the top plane, which is unusually great, the maximum being 67 mm., or 2⅝ in. The incidence of the top planes, as stencilled at various points is 5½ deg., while the lower plane incidence at the root is 5¾ deg., and at the tips 5½ deg. The trailing edge of the top plane is formed of either wood or steel tube, but that of the lower plane is of steel wire, the pull of the fabric resulting in a scalloped effect. The center section is supported from the body on a cabana of streamline section steel tubes, welded together.

In front elevation the cabana struts slope outwards, being braced from the upper rear spar by cross-wires, but in front, owing to the engine, this is not possible, so wires have been taken from the cabane strut socket on the top plane to the anchorage for the main lift wires on the body. The wiring between the planes is of cable, while a drag wire is taken from the nose of the machine to the outer socket on the lower plane.

The body is very deep and bulky, the length from nose to rudder-post being 22 ft., 11 in., the maximum depth being about 4 ft. 6 in., and the width 3 ft. 2½ in.

It is built apparently of longerons, to which are tacked boards of three-ply, while the fairing or superstructure in the vicinity of the pilot's seat is formed by diagonal bands of three-ply, somewhat similar to the Pfalz body. The mounting for the revolving gun ring, which is 2 ft., 10¼ in. outside diameter is built in and developed from the body, as also is the fin, which extends below the lower tail plane and carries the tail skid. In the rear cock pit is fixed a wireless outfit.

The detail which has created a great amount of interest is the arrangement of the biplane tail plane. The fixed portion of the lower tail plane is built in the body and is covered, top and bottom, with thin three-ply.

The elevators are built of steel tube. Only one control crank is fitted, this occurring immediately in the center. The upper plane is attached directly to the fin, and is much smaller, both in length and width, and is covered with fabric. The elevator is in one piece and carries, as in the case of the lower tail plane, one crank. An interesting point is that both levers are connected up to a vertical rod, situated in the fin, so that all control wires are arranged inside the body, excepting those to the rudder. By this arrangement comparatively simultaneous movements in both elevators is assured.

The two planes are connected together by a steel stay of streamline section on each side of the fin.

The biplane form of tail was probably chosen as an alternative to a large monoplane tail, which, besides affording cover to a pursuing machine, would require some form of staying or bracing and might conceivably be as heavy as the biplane tail, but not nearly so compact, and certainly not so strong. Some confusion exists as to the make of the engine employed. This is variously reported as being an Opel 180 hp. but the engine in the machine under discussion is almost certainly an Argus of 180 hp., although there is the possibility that the engine is an Opel, built under license by the Argus firm.

The air screw is a Reschke of 2.85 m. diameter, and 1.55 m. pitch, without the spinner now usually seen on enemy machines.

Aircraft (London), May, 1918

Outlook for Commercial Aeronautics—The British aircraft industry is now established on a basis which facilitates large scale production, and technical advances have been made during the war period which represent many years of normal development. The new designs of aircraft have undergone such strenuous tests in war service that their capacity for ordinary commercial work has been most amply demonstrated, and a vast amount of information and experience accumulated not only on the manufacturing side but on the purely scientific aspect of the behavior of different designs under all kinds of atmospheric conditions and elevations, which will enable commercial problems to be attacked in a spirit of confidence which would otherwise have been lacking. It is of equal importance from the point of view of the future of the industry that new sources of raw materials have been opened up, a large body of skilled workers made available, and supplies of trained pilots assured for all commercial purposes for many years to come. The foundations of future success have, it cannot be doubted, been firmly laid.

One fact emerges quite clearly from the somewhat contradictory views which have been put forward on the future of aeronautics: it is that, altogether apart from the question of the Government should aid commercial development, the military situation at the close of the war is likely to be such that it will be absolutely essential in the national interests that our output of aircraft should keep pace with similar develop-

ments in other countries. This national requirement no doubt implies a continuance, perhaps in a modified form, however, of that Government control of industry which there is a general desire to eliminate at the earliest possible moment.

A large demand for aircraft for commercial purposes is not coming immediately, and unless Government orders were forthcoming it would be vain to hope that the production of our airplane factories could be anything like absorbed by the commercial demand, so that a period of financial stress would be ushered in and the industry suffer a serious setback at a moment when enemy aircraft manufacturers, freed from the burdens of excess profits taxation, and therefore in possession of large fighting funds and assured in any case of Government encouragement, might be able to dominate the commercial field.

The Government orders, which will obviate this crisis, will not probably be confined to military machines, but even if they were it is quite obvious that the types of aircraft which have been evolved for war purposes are quite applicable to commercial needs, so that the production of military and commercial machines can go on concurrently. It is likely, however, that Government aid will also take the form of air services for mails.

Negotiations which are now in progress with Norway for the establishment of an air mail service between England and Scandinavia indicate that this view as to the first commercial application of aircraft is based on sound reasoning. The aim of the company, which has been formed, is to set in operation a regular mail service by air between Aberdeen and Stavanger, and to have auxiliary services from Stavanger to Christiania, Copenhagen, Bergen and North Norway. Arrangements have been already made for opening during the present month of a regular air route between the Skaw and Copenhagen. It may be taken for granted, therefore, that air mail services between Great Britain and the Continent will be one of the first developments on the commercial side, and that these services, following the usual practice in other methods of transport, will be subsidized by the Government of different countries. It is considered probable also that at a comparatively early date air services will be in operation in many sparsely populated territories where traffic possibilities do not at present justify the cost of railway construction and a good case can be made out for the granting of a subsidy in these cases. Passenger and ordinary parcels services would constitute the next stage of development, and various experts have gone so far as to draw up time-tables and form estimates of operating costs and probable passenger and parcel rates for services between great centers of population.

***Flying* (London), May 22, 1918**

Design and Prophecy.—By Sidney Barr.—The internal combustion engine in its present form, failing the discovery of still further lightening processes and modifications, has practically reached its lowest limit of weight per horse power. Advance is possible, however, by adoption of a principle which is already old in the case of steam-engines, that of multiple-expansion engines. The internal-combustion engine of to-day is a single expansion engine: the explosive charge is used once, in one cylinder, and then a great part of its heat and power is exhausted directly to the atmosphere wasted. It may be said that the problem of using the gases a second time in a second cylinder is an insuperable one, but the same might have been said of the steam-engine before the adoption of high and low compression cylinders in the same engine. The principle must be different from that of the steam engine, of course, but the problem is not insuperable, by any means.

A further modification, in which experiments are already being made, is that of giving a propulsive impetus to the piston in both directions, so that in a complete cycle of four strokes two are firing strokes! It is not yet ascertained—or if it is the conclusions have not yet been made public—what advantage is gained from this modification of design when it is compared with the ordinary four-stroke engine.

Considered from the point of view of aircraft such an engine ought to show a reduction of weight per horse power; against this is the fact that each cylinder must be provided with two sets of valves, unless an utterly revolutionary type of engine is introduced, and this provision would tend to modify the diminution of weight, though even then there ought to be a balance to the goods. The design as a whole, however, is still in the experimental stage, and nothing can be said about its value until it has been thoroughly tried out in practical aeronautical work, for practice has a habit of upsetting theory where aerial matters are concerned. If this double-impulse engine—to coin a title for it—fulfils its purpose to the extent anticipated by its best friends it will go a long way toward eliminating the problem of "weight per horse-power" by reducing that weight very considerably indeed. But with regard to that, we must wait for adequate practical tests before admitting the value of the new design.

The introduction of multiple-expansion engines of the internal-combustion order, should such a step ever be found practicable, and it may be counted among the range of possibilities, would affect the "weight per horse-power" problem very considerably, and in that respect ought to prove beneficial. But its chief benefit would be in another direction altogether, namely, it would increase the mileage per gallon of fuel carried. For it is obvious that if the full value of every cylinder charge is utilized for propulsive purposes, instead of exhausting half or more of that value into the air through the exhaust valves, a gallon of liquid fuel will serve to propel the engine twice as far, or more. Probably, when it comes to practice as against theory, transmission friction and its friends would serve to reduce the mileage per gallon to some extent, but there would still be such a balance as would make the multiple-expansion engine immensely superior to the present single-expansion type of internal-combustion engine, sufficiently superior, at any rate, to justify its general adoption in place of present types. The benefit would be most noticeable in the case of long-distance flights, when the reduction in the amount of fuel necessary for the flights would admit of substantial increase of the useful load. And, in commercial aeronautics, such a pound is more than worth considering—it is vital.

The *Aeroplane*, May 22, 1918

A Great Italian Pilot.—All who were connected with international aviation in its early days will hear with regret of the death of Emilio Pensuti, who was one of the earliest and greatest of Italian pilots. For the past five years he has been chief pilot of the Caproni firm, and to his skill and experience is very largely due the development of the great Caproni multiple-engine biplanes and triplanes which have done so much valuable work in the war.

Pensuti met his death in a truly heroic manner which places him on a level with any other of the pilots who have died in air fighting. He was flying with an important Italian officer on board, when, owing to some insufficiently explained cause, the machine caught fire. In order to save his distinguished passenger Pensuti directed him to climb out on to the wing of the machine away from the fire, and he himself stuck to his post in the midst of the flaming body of the machine till he landed it correctly, and thus saved the life of his passenger. He died very shortly afterwards as the result of his burns.

If he had been content to let his passenger take the risk of being smashed, he might possibly have saved himself by letting go of the controls and climbing out along the wings in the hope that the machine would fall in such a way as not to kill him when it hit the ground, but this action would have lessened the chance of saving his passenger's life. Therefore, he made certain of saving the passenger even at the cost of his own life.

During his services with the Caproni Company he made over 3,000 flights on all types of that firm's machines. His death is an irreparable loss to Italy.

***Aircraft* (London), May, 1918**

The Fifteen-Tonner.—By the end of 1915, airplanes weighing, all on, about ten tons, and having a useful load of about three tons, were under construction. We know now that it is possible to build big machines, to equip them with a great total horsepower and to insure (as far as is humanly possible) long flights without halt or mishap. All that can be done, yet the commercial side of the matter does not appear any clearer, because the commercial conditions are fundamentally different from those operating now. The really satisfactory advance consists in the greater reliability which has been effected. The engines and the machine are better, with the result that calculations of useful load and actual performance are less tentative than they were two or three years ago. At the same time impartiality compels one to own that the vital calculation must wait awhile. In the meantime improvements are being made.

News of the Fortnight

Reciprocal Patent Rights

The Senate on June 19 passed the Senate bill 3524 to extend temporarily the time for filing applications for patents and registration of trademarks, etc.

In the trading-with-the-enemy act it is provided that Germany and her allies may file applications in this country more than a year after having been filed in their own countries, whereas a citizen of a country allied with the United States must file in this country within one year from the time the application is filed in his own country, otherwise his patent when taken out here is invalid.

It gives to our Allies who are unable to file an application during the war or within six months thereafter, on account of conditions arising out of the war, an extension of nine months therefrom, but expressly excludes from this privilege countries whose laws do not extend substantially similar courtesies to United States citizens. It also relieves from default all applications filed since August 1, 1914.

Conservation of Platinum

The Bureau of Mines of the Department of the Interior has issued an appeal to the American people for the conservation of platinum, which is used, among other things, in the manufacture of ignition points in airplanes. Speaking in the House on June 7, Representative Henry T. Rainey severely criticized the War Industries Board for its unnecessary, ineffective and wholly insufficient attempts to conserve the supply.

Aircraft Offices Move

The offices of the Bureau of Aircraft Production, including those of Director John D. Ryan and Chief of the Production Division Archer A. Landon, and the offices of the Aircraft Board, of which Mr. Ryan is chairman, have been removed to Building D, on Missouri Avenue and 4½ and 6th Streets, N. W., Washington, D. C. All these offices were formerly located on the ninth floor of the Munsey Building.

Besides the above, Building D now houses the office of Assistant Director of Production William C. Potter, the departments of the Production Division, the Department of Military Aeronautics, and the office of the Joint Army and Navy Board on Aeronautic Cognizance.

Aeronautic Cognizance Board

Rear Admiral William R. Shoemaker, representing the Navy, has been appointed a member of the Joint Army and Navy Board on Aeronautical Cognizance, in lieu of Capt. F. H. Clark.

First Lieut. W. W. Williams, S. R. C., A. S., has succeeded Capt. J. R. Whitehead as recorder to the Board.

The office of the Board has been removed from 1107 H Street, N. W., Washington, D. C., to the Department of Military Aeronautics, at Sixth Street and Missouri Avenue, N. W.

Aeronautical Instrument Corp. Formed

A Hausletter has organized the International Aeronautical Instrument Corp., with offices at 308 Madison Avenue, New York City, to carry on the business of manufacturing altimeters, barographs, airspeed indicators and compasses. Mr. Hausletter is president and treasurer of the new corporation and A. Johns is secretary.

Castor Beans Import Licenses Revoked

The War Trade Board has made a new ruling that all outstanding licenses for the importation of castor beans and castor oil from the West Indies, Mexico, Central America, Colombia and Venezuela (except those wherein the United States Government appears as consignee) have been revoked as to beans shipped made after June 10, 1918.

Hereafter no licenses for importations from those countries will be issued, except when the United States Government is the consignee or when the importation is approved by the Bureau of Aircraft Production. All applications for the importation of these commodities from these countries when a consignee other than the United States Government is named will be referred to the Bureau of Aircraft Production for approval.

New Aviation Fields

Three new Army aviation fields will be put into operation before long. These are located at Babylon, N. Y., Buffalo, N. Y., and Columbus, Ohio.

The field at Babylon, L. I., is situated on the site of the Belmont racetrack, which gained fame through the International Aviation Meeting held there in 1910. Two squadrons will be stationed at Belmont Field.

The new field at Buffalo will be an acceptance field for the final tests of machines delivered by the Curtiss Aeroplane and Motor Corp. Other acceptance fields are located at Detroit, Mich., Elizabeth, N. J., and Dayton, Ohio.

Four hundred acres of land have been commandeered by the War Department as the site for the Buffalo acceptance field. The property extends from Elmwood Avenue on the east to Military Road on the west, to the town line of Kenmore on the north and to the Delaware & Lackawanna Railroad tracks on the south. The laying out of the field will require the closing of a section of Elmwood Avenue and twenty other streets.

Contracts for the construction of the necessary buildings on a cost-plus basis have been let to a Buffalo firm and the work will be begun at once. The property is valued roughly at $1,000,000.

About twenty hangars, eight storehouses, barracks for 500 men and quarters for officers will be erected. The estimated cost is $500,000, thus making the investment approximately $1,500,000.

The aviation camp to be established at Columbus, Ohio, will be situated on the Ohio state fair grounds. It will be used for preliminary training of aviators.

Practically every one of the large buildings on the grounds will be used for the students, and some remodeling and new construction will be necessary. Work will be started at once.

The aviation field established some time ago, two miles south of Austin, Texas, by the Chamber of Commerce of that city, has been leased to the Army for one year. The field has been named Penn Field, in honor of Cadet Eugene D. Penn, who was recently killed while flying in Italy.

Senators Visit the Standard Plant

The Senate Committee which is making a tour of inspection of the airplane plants visited the factories of the Standard Aero and Standard Aircraft Corporations at Elizabeth, N. J., June 19.

Senator James A. Reed, of Missouri, speaking for the committee, said: "We find better conditions as to quantity production."

Other than this none of the Senators spoke, as the report of the investigation must first be made to the Military Affairs Committee of the Senate.

The other members of the committee are Senator Joseph S. Frelinghuysen of New Jersey, Senator Harry S. New of Indiana, and Senator Charles S. Thomas of Colorado.

Changes in Air Personnel Section

Lieut.-Col. W. E. Gilmore of the Air Personnel Division has been transferred to the Board of Control. Lieut. Col. Franklin R. Kenny of the Signal Corps has succeeded Colonel Gilmore in the Air Personnel Division.

New Wind Tunnel

Throop College, Pasadena, Cal., is constructing a wind tunnel, and advices state that it is expected that it would be completed on or about July 15.

Aeronautical Commission to Go Abroad

Charles H. Willard, chief engineer of the Aeromarine Plane and Motor Co., has been given leave of absence by his company so he can join a Government aeronautical commission that is shortly to leave for France and England. It is understood that the purpose of the trip is to secure the latest military information upon aircraft and to translate it into production for next year's American airplane program. Colonel Hall and Major Murnan of the Aircraft Production Division are other members of the delegation.

Army Appropriation Bill

The annual Army Appropriation Bill, carrying a total of about $12,088,852,000 67, which passed the House last month, reached the Senate on June 24. No reduction was made in the bill as reported by Senator Chamberlain from the Committee on Military Affairs in the items of $884,304,758 for aviation and $105,946,054 77 for the Signal Corps, as adopted by the House, nor in any other item.

An increase of $47,000,000 is made by the Senate Committee and several amendments of a legislative nature are added as riders. Among them are amendments authorizing the formation of an aircraft production corporation with a capitalization of $100,000,000, empowering the President to commandeer lumber for airplanes and other purposes.

Personnel of the Aircraft Board

Under the law the Aircraft Board consists of nine members, three of whom must be civilians, three representatives of the Navy and three representatives of the Army. The personnel of the Board now is composed as follows:

Civilians—John D. Ryan, Richard F. Howe and William C. Potter.

Navy—Rear-Admiral David W. Taylor, Capt. Noble E. Irwin and Lieut.-Commdr. Arthur K. Atkins.

Army—Maj.-Gen. William L. Kenly (who succeeds General Squier), Col. R. L. Montgomery and Col. E. A. Deeds.

Airplane Spruce Contracts

Contracts for airplane spruce were recently let by the Quartermaster's Department of the Army, as follows: Elmer G. Byron, Houlton, Me., C. S. Dearing, Derry Village, N. H., E. D. Hodgson, Cambridge, Mass., H. Newton Dayler, Granville, N. Y., Sherman Lumber Company, Sherman Station, Me., H. H. Putman, Danforth, Me., Kellogg Lumber Company, Long Point, Me., Jackman and Garland, Lincoln, Vt., S. W. Collins and Son, Caribou, Me., J. F. Gerrity Company, Boston, Mass., G. A. Meyer, Lincoln, Vt., Nelson Murray, Lincoln, Vt., S. G. Tisdale, East Middlebury, Vt., Bentley and Butterfield, East Middlebury, Vt., Farr and Kennedy, Rochester, Vt., Rinaldo A. Whittier, Hancock, Vt., N. D. Rice and Son, Granville, N. Y., George H. Benn, Hodgson, Me.; Finch Pryor and Company, Glen Falls, N. Y., W. Edward Benson, Greenfield, Mass., Martinon Lumber Company, Bangor, Me., Pejepscot Paper Company, New York City, Emporium Lumber Company, Utica, N. Y., Santa Clara Lumber Company, Tupper Lake, N. Y., Ryther Purdy Lumber Company, Van Buren, Me.

Advertising Folder

The Aluminum Castings Co. of Cleveland, Ohio, manufacturers of Lynite and Lynux products, have recently sent out to the trade a folder advertising Lynite pistons.

Naval Air Mechanics Wanted

One hundred and twenty men are wanted at once for the Navy mechanics' school at the marine barracks, Philadelphia, Pa., now being organized. These men will enter the mechanics' school in classes of sixty, two classes, or 120 men, being wanted as soon as possible. Upon completion of the course in the school, and after receiving a course in gasoline engines, these men will be sent to aviation duty as mechanics. Men with experience as garagemen, mechanics, machinists, coppersmiths or welders are desired.

Men are also wanted to take the course of study at the school for aviation mechanics at Great Lakes Naval Training Station.

Men who have knowledge of gasoline engines, magneto work or carburetors, the taking up of bearings, fitting piston rings, assembly and machine tool work, are particularly wanted.

The advanced instruction covers practical work with all the latest types of airplane engines. All graduates are given ratings as petty officers, with a splendid chance for advancement.

Moving to Increase Production

The Pressed and Welded Steel Products Co., Inc., manufacturers of a large number and variety of Exhaust Headers and other airplane parts, will move from Flushing, N. Y., into new and larger quarters at Long Island City, which will afford facilities for increased production.

New Members of N. A. C. for A.

Several changes have just occurred in the membership of the National Advisory Committee for Aeronautics.

Maj.-Gen. William L. Kenly, Director of Military Aeronautics, has been appointed to the committee in place of Maj.-Gen. George O. Squier, Dr. Wallace C. Sabin, of the Bureau of Aircraft Production, succeeds Col. Virginius E. Clark, and Dr. John R. Freeman, of Providence, R. I., takes the place of Byron R. Newton, Collector of the Port of New York.

Doehler Die-Casting Co. Expands

The Toledo, Ohio, plant of the Doehler Die Casting Company, which is housed in a modern factory building completed about a year ago, has in this short time outgrown its quarters.

In order to provide for this expansion the company has found it necessary to take over the adjoining plant of the Ohio Electric Co., doubling its present capacity.

While a large part of the plant's activities are devoted to Government war work, the company attends to the needs of the regular trade.

Airplane Repair Depot at Montgomery

The Department of Military Aeronautics has in course of construction an engine, plane and repair depot at Montgomery, Ala. The work was begun on the building on or about April 15, and is being done by the Engineering Section of the Supply Division, Signal Corps, which under the reorganization is now a section of the Department of Military Aeronautics. The building is of wood construction, will cost about $100,000, and will be completed on or about July 1.

Klaxon Absorbs Stentor Co.

The Klaxon Co. of Newark, N. J., has absorbed the Stentor Electric Mfg. Co. of Long Island City, N. Y.

The Autophone and other loud-speaking telephone instruments formerly manufactured by the Stentor Co. will be marketed by the Klaxon sales organization.

The Autophone business will be handled from the Klaxon Co.'s office in the Hyatt Building, Detroit, Mich.

Search for Propeller Stock

The United States Department of Agriculture announces that the War Department and the Forest Service are aiding the Boy Scouts in efforts to find black walnut timber needed for airplane propellers, following President Wilson's appeal to the Scouts to locate supplies of the "Liberty Tree." Special report forms have been prepared for use of the Scouts, who will submit them for tabulation to the Forest Service, which in turn will report the results to the War Department.

The bulk of the standing black walnut is said to be in farmers' woodlots in the Middle West, the Middle Atlantic States, and the southern Appalachians, and it is mainly these sources that the Scouts will comb in their search for material.

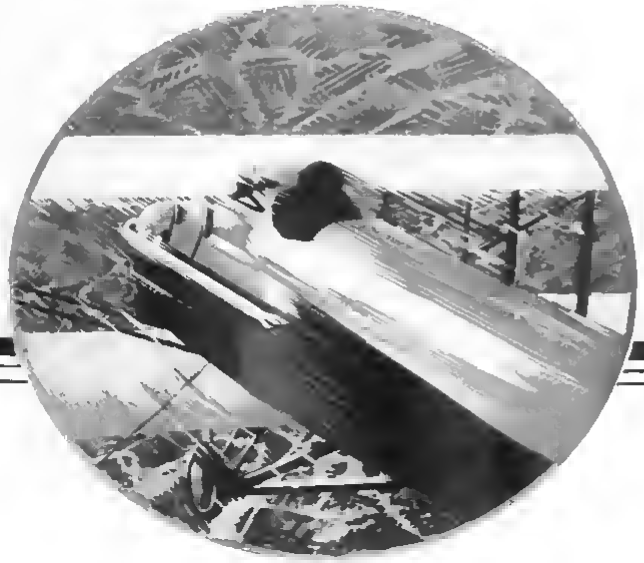
J. G. Bennett Pioneer in Aeronautics

Concerning the death of James Gordon Bennett, proprietor of the New York *Herald*, the London *Aeroplane* says:

Mr. Bennett endowed the International Balloon Race for the first three years of its existence with a trophy and a series of large prizes. The first race was held in 1906, the start taking place at Paris, the winner being Lieut. Lahm, an American pilot. Subsequent races were won successively by Germany, Switzerland, America, America again, France, and by America a third time.

At the first big public airplane competition held at Rheims in 1909 Mr. Gordon Bennett offered a trophy for the greatest speed round a marked course, which was won by Glenn H. Curtiss on a Curtiss airplane. The trophy which was international in character was open for competition every year under rules determined by the F.A.I. Congress, were held up to 1914, when the outbreak of war stopped the race which would have been held in the late summer.

The Gordon Bennett Cup was won in 1910 by Claude Grahame-White on an 100 h.p. Blériot monoplane at Belmont Park, New York; in 1911, by Charles Weymann, on a 100 h.p. Nieuport monoplane for U. S. A.; in 1912, it was brought back to France by Jules Vedrines on a 140 h.p. Deperdussin, and kept in France in 1913 by Marcel Prévost on a 160 h.p. Deperdussin, who, for the first time in history, covered practically 125 miles round a closed course within the hour.



We manufacture the following parts for airplanes

All Standard Types of Turnbuckles Tie Rods and Clevises Thimbles Bolts and Clevis Pins

THE

DAYTON METAL PRODUCTS CO.

DAYTON, OHIO, U. S. A.

Ready for the duty asked—

It's hard, when you see a squadron of planes at rest, to picture them as a mechanical device that has overcome the Law of Gravity For they are heavier than air. And if you hold a Hess-Bright Ball Bearing in your hands it is equally as hard to picture it as an ingenious device that has all but mastered fraction For it is simply a rugged collar of steel encircling a set of true spheres of steel. And it is so small compared to other important parts in plane and engine construction But there are none that are more important. Speed, climbing power, control, engine action—all are dependent on bearing performance Twenty-six places exist where Hess-Bright Ball Bearings will help to build air supremacy That's why makers of planes buy the best. For while the Hess-Bright first cost is more, in the long run it is the least expensive And it has been by the performance it gives that its reputation has been established

THE HESS-BRIGHT MANUFACTURING COMPANY
Philadelphia, Pennsylvania

Where Performance takes Preference over Price

NEW ENDURANCE RECORD

Established by

Union Airplane Motor at U. S. Aeronautical Testing Laboratory, Navy Yard, Washington, D. C.

Best previous record exceeded by fifty per cent.

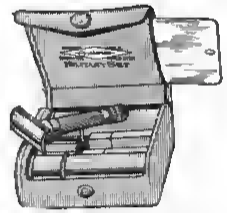
UNION GAS ENGINE COMPANY

ESTABLISHED 1885

OAKLAND - - - CALIFORNIA

Gillette SAFETY RAZOR

The New U. S. Service Set—A solid metal case heavy nickel plated and embossed with the insignia of the U. S. Arms and Navy Stresses this compact 1¾ inches wide 4 inches long by inch thick 12 double-edged Gillette Blades 1½ Shaving Edges! Contains a nickel plated Gillette Safety Razor and Blade Box in indestructible Trench Mirror inside the lid $5



Military Set No. 18—For Uncle Sam's Officers a Gillette Combination Set, in case of U. S. Regulation Khak twill — nickel plated "Bulldog" Razor indestructible Trench Mirror fitted in pocket in lid Shaving Brush and Stick Gillette Shaving Soap in nickel plated Holders two Blade Boxes 12 double-edged Gillette Blades 1½ Shaving Edges) $7

War service is throwing the spotlight on the Gillette

There are mighty few personal belongings a man in the Service can pack around—and the greatest of his comforts is his Gillette.

Wind-chap, sun-burn, cold water, cold weather only give the Gillette a bigger opportunity to show *service*.

There isn't a mile of the battle-fronts, nor a ship of the Allied Nations, but has its Gillette users by the tens and the hundreds. The compact, portable razor that can always be depended on for *service*.

Have you seen the new Gillette Sets specially made for the fighting man? Two of them are illustrated on this page. They were designed by members of the Gillette Organization in the Service — men who know what the fighting man is up against.

Simple and compact, fit the pack, the pocket or the ditty box. No strops or hones to clutter up the kit. Blades always sharp, always ready. No Stropping—No Honing. When a man wants new Blades he can get them in any Post Exchange, Ship's Canteen, or Y. M. C. A. Hut, here in America or overseas.

Our Paris Office carries stocks — is constantly supplying the American Expeditionary Forces. Gillette Safety Razors and Blades on sale everywhere in France, England, Italy, and the Eastern battle fronts.

Gillette Safety Razor Co of Canada, Ltd. 73 St. Alexander St. Montreal

Gillette Safety Razor Societa Anonyme 17 Bis, Rue La Boetie Paris, France

Here's the Way to Get 100% Efficiency Out of Your Gillette

Try this when you shave tomorrow morning. Lather the beard thoroughly, and rub well in — that's essential with any shave.

Put in a new blade and screw the handle down tight. If you want a specially close shave, unscrew the handle a part turn.

Hold the razor naturally and easily and tilt the handle so you can just feel the blade engage the beard.

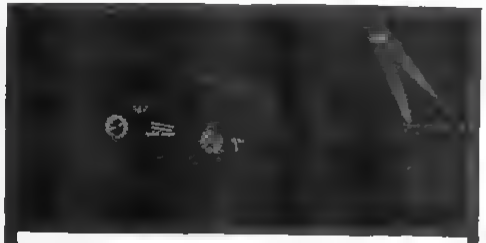
Then shave with short slanting strokes. It doesn't require any brute force to shave with a Gillette—the razor does the work.

Gillette Safety Razor, Ltd. 200 Great Portland St. London, W., England

A. G. Micheles 53 Liteiny, Petrograd, Russia

Vedova Teoi Quirino & Figli Via Senato, 18 Milan, Italy

Gillette Safety Razor Company
Boston Mass·U·S·A·



R L M on Battle Planes

AVIATORS in the fighting forces do much of their flying at night. It is of paramount importance that instrument dials be clearly visible at all times. That explains why Radium Luminous Material (RLM) is on aviation instruments in use at the "front."

R L M is reliable as gravity and almost as permanent. No wires, no switches, no upkeep.

Instrument manufacturers will receive further information by addressing Dept. H.

Radium Luminous Material Corporation

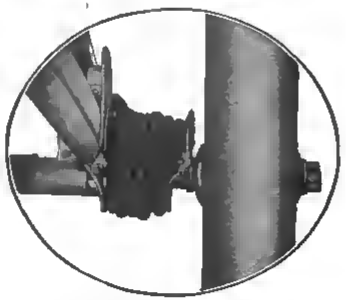
55 Liberty St. New York City

Plants: Orange, N. J. Boonton, N. J.

Mines: Colorado, Utah

Elastic Aviation Cord

For Shock Absorbers on Airplanes



We originated and have developed this special heavy elastic cord for airplane shock absorbers.

We are the largest manufacturers in the world of Heavy Elastic Cord and owing to our factory capacity we can make prompt deliveries.

Samples on request

J. W. WOOD ELASTIC WEB CO.

FACTORY: STOUGHTON, MASS.

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Fahrig Anti-Friction Metal

The Best Bearing Metal on the Market
A Necessity for Aeroplane Service

Fahrig Metal Quality has become a standard for reliability. We specialize in this one tin-copper alloy which has superior anti-friction qualities and great durability and is always uniform.

When you see a speed or distance record broken by Aeroplane, Racing Automobile, Truck or Tractor Motor, you will find that Fahrig Metal Bearings were in that motor.

FAHRIG METAL CO., 34 Commerce St., N.Y.

TURNBUCKLES

of the

Highest Quality

to Meet the Most
Exact Requirements

Standard Turnbuckle Company

CORRY, PA.

New York Office: Woolworth Building

Aluminum Company of America

PITTSBURGH, PA.

MANUFACTURERS OF

Aluminum Ingot, Sheet, Tubing, Wire, Rod, Rivets, Moulding Extruded Shapes, Electrical Conductors

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Chicago . . . . . 1500 Westminster Building
Cleveland . . . . . 950 Leader-News Building
Detroit . . . . . 1512 Ford Building
Kansas City . . . . . 508 R. A. Long Building
New York . . . . . 120 Broadway
Philadelphia . . . . . 1216-1218 Widener Building
Rochester . . . . . 1112 Granite Building
San Francisco . . . . . 731 Rialto Building
Washington . . . . . 509 Metropolitan Bank Bldg

CANADA
Northern Aluminum Co., Ltd . . . . . Toronto

LATIN AMERICA
Aluminum Co. of So. Am. . . . . Pittsburgh, Pa.

ENGLAND
Northern Aluminum Co., Ltd . . . . . London

Send inquiries regarding aluminum in any form to nearest Branch Office, or to General Sales Office

We have received two notices from the Government:

1. *"Your application for a license is disapproved"*
2. *"Since your Penguin does not leave the ground there is nothing, of course, to stop the use of them"*

Wherefore,

YOU MAY LEARN TO FLY BY THE BEECH FLIGHT SYSTEM

PROCEDURE:

You apply for a license for the purpose of making practice flights on Salt Plains, Oklahoma, to the Joint Army and Navy Board for Aeronautic Cognizance, 1607 H Street, N. W., Washington, D. C.

You then pay us a fee of $125, for which we prepare you to the point where you may safely go up alone in our airplane which we rent you for 60c. each minute of actual flight, including the cost of breakage, with the proviso that you follow our instructions because, while our Penguin practice makes the operation of the airplane in the air as easy matter, there still remain the principles of the landing to teach, which is easy by our system providing instructions are followed.

The Beech Flight System Corp.
Cherokee, Oklahoma

"The Cavalry of the Clouds and The Navy That Flies"

are now being given exclusive and intimate expression through the

Air Service Journal

the official publication of the *Air Service Association* — the only service organization of the aviation branches of the Army and Navy.

The Association was organized within the service, by flying officers, who elected their own officers, and its membership is made up of the men who are fighting and will fight our air battles.

In addition to the established editorial features of AIR SERVICE JOURNAL—all the news of the AIR SERVICES each week, foreign aeronautical news, notes of the flying fields and ground schools, Air Service orders, special articles on aeronautical subjects, and photographs of aerial happenings all over the world—it will feature exclusive articles by officers of the Air Services through the editorial board of the Air Service Association.

Special offer to new subscribers—two dollars a year, 52 issues, or one dollar for six months, 26 issues. Regular price three dollars, single copies ten cents

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Enclosed is { money order / check } for dollars for which send me AIR SERVICE JOURNAL for { one year / six months }

Name

Address

Aeronautical Trade Directory

AVIATION AND AERONAUTICAL ENGINEERING will furnish information and addresses of companies listed below.
Names of Advertisers in this issue are printed in capitals
See Index to Advertisers on page 832

ACCESSORIES AND INSTRUMENTS

Advance Felt Specialty & Cutting Co
INTERNATIONAL AERONAUTICAL INSTRUMENT CORP
King, Julius, Optical Co.
THE MOTOMETER CO
National Gauge & Equipment Co
O'Hara Waltham Dial Co.
Mateo Waller
SPERRY GYROSCOPE CO
Standard Aeronautical Co
TAYLOR INSTRUMENT COMPANIES
Western Electric Co.

AIRPLANES

AERONARINE PLANE AND MOTOR CO
Blackhawk Airplane Co
BOEING AIRPLANE CO
Breese Aircraft Corp.
THE BURGESS COMPANY
California Aviation Co.
Cooper John D., Aeroplane Co.
CURTISS AEROPLANE & MOTOR CORP
DAYTON WRIGHT AIRPLANE CO
Geo Lauriers Aircraft Corp.
Dewey Aeroplane Co.
Engel Aircraft Co.
Falcon Mfg Co.
Fisher Body Corp
Fowler Airplane Corp.
Gallaudet Aircraft Corp
Heinrich A S. Corp.
Lassiter Aircraft Co
Lawrence-Lewis Aeroplane Co
Lawson Aircraft Corp
Lewis & Vought Corp.
Loening Aeronautical Eng Corp
Longren Aeroplane Co
L. W. F. ENGINEERING CO
MARTIN, GLENN L. CO
Michigan Aircraft Corp.
ORDNANCE ENGINEERING CORP
Patterson Aeroplane Co
Petree, Sam'l R., Aeroplane Corp.
SMITH KYLE, AIRCRAFT CO
Sperry, Lawrence, Aircraft Co.
Springfield Airplane Co
STANDARD AIRCRAFT CORP
Sturtevant Aeroplane Co.
THOMAS-MORSE AIRCRAFT CORP
The Willys-Morrow Co.
WITTEMANN LEWIS AIR CRAFT CO.
WHITTEMORE HAMM CO
WRIGHT-MARTIN AIRCRAFT CORP

AIRPLANE ENGINES

AERONARINE PLANE AND MOTOR CO
Ashmusen Mfg Co.
Continental Motors Co.
CURTISS AEROPLANE & MOTOR CORP
Dayton Aero Motors Co.
Detroit Gas Turbine Corp.
DUESENBERG MOTOR CORP
General Ordnance Co.
General Vehicle Co.
Gyro Motor Co.
HALL-SCOTT MOTOR CAR CO
Kemp Machine Works.
Kessler Motor Co.
Knox Motors Co
Nordyke & Marmon.
Packard Motor Co
Roberts Motor Mfg. Co.
Rolls-Royce, Ltd.
Springfield Motors Co.
Sterling Engine Co.
STURTEVANT E. F., CO.
Trego Motors Corp.
THOMAS MORSE AIRCRAFT CORP
UNION GAS ENGINE CO.
Van Blaack Motor Co.
Willys-Overland Co.
WISCONSIN MOTOR MFG CO.
World a Motor Co
WRIGHT-MARTIN AIRCRAFT CORP

AIRPLANE PARTS

Aircraft Parts Mfg. Co
American Body Co
ASTORIA VENEER MILL & DOCK CO
BARCALO MFG CO.
Century Telephone Construction Co.
Chicago Aeronautical Supply Co.
DAYTON METAL PRODUCTS CO
ERIE SPECIALTY CO.
Halbrook Co.
HAWNEER MFG CO
LEVETT, WALKER M., CO.
New Jersey Veneer Co
Pressed & Welded Steel Products Co.
Rogers Construction Co.
Standard Parts Co.
Welch Mfg Co
WHITTEMORE HAMM CO
WIDMAN, J C, & CO
Willys Morrow Co
Wilson Cabinet Co

ALUMINUM

Aderal Co of America
ALUMINUM CASTINGS CO
ALUMINUM CO OF AMERICA
American Metal Co Ltd
LEVETT, WALKER M., CO.
LEYGRAND & CO
McAdamite-Aluminum Co.
NO-LUMINUM MFG & ENG CO. (SOLDER)
STIMPSON, EDWIN B., CO.
United Smelting & Aluminum Co.

AVIATION SCHOOLS

American School of Aviation
America Trans-Oceanic Co.
ATLANTIC COAST AERONAUTICAL STATION
Beam Airplane Co.
Blackhawk Airplane Co.
CURTISS TRAINING SCHOOLS
EAGLE AVIATION SCHOOL
The Hydroaircraft Co.
Michigan State Auto School
Moler Aviation Instructors
Penn. State School of Aero-Mechanics
Stinson School of Aviation
WHITTEMORE HAMM CO

(Continued on page 821)

Aeronautical Trade Directory—*Continued*

BALL BEARINGS
THE FAFNIR BEARING CO
GURNEY BALL BEARING CO.
HESS BRIGHT MFG CO
NEW DEPARTURE MFG CO
NORMA COMPANY OF AMERICA
S K F BALL BEARING CO
U S. Ball Bearing Mfg Co.

BALLOONS: DIRIGIBLES
Burdette Oxygen Co.
Connecticut Aircraft Co.
Custer Specialty Co. (Statoscope)
Gas Engineering Co (Gas Plants)
GOODYEAR TIRE AND RUBBER CO
United States Rubber Co

BAROGRAPHS AND BAROMETERS
Green Henry J
INTERNATIONAL AERONAUTICAL INSTRUMENT CORP
Bussfeld & Lorch
TAYLOR INSTRUMENT COMPANIES

BEARING METALS
ALUMINUM CASTINGS CO
AMERICAN BRONZE CORP
FAHRIG METAL CO
LEVETT WALKER M. CO
Magnolia Metal Co.

BUSHINGS
ALUMINUM CASTINGS CO
AMERICAN BRONZE CORP
Bound Brook Oil-less Bearing Co

CARBURETORS
H. & N Mfg. Co
Master Carburetor Co.
Miller Carburetor Co.
Stromberg Motor Devices Co.
Wheeler & Schebler
ZENITH CARBURETOR CO

CLOCKS AND WATCHES
Chelsea Clock Co
Depottier, J., & Son
Hamilton Watch Co
Ingersoll Robert H., & Bros.
Waltham Watch Co

CLOTHING
Abercrombie & Fitch
Cross, Mark
N Y Sporting Goods Co.
Rainwear Co.
Rogers, Peet & Co.
Sanders Company
Spalding, A G., & Bros

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SPERRY GYROSCOPE CO
Star Compass Co
TAYLOR INSTRUMENT COMPANIES

DOPE AND VARNISH
Adams & Elting Co
American Emaillite Co
BROOKLYN VARNISH MFG CO
CHEMICAL PRODUCTS CO.
Conover, The C. E., Co.
DU PONT CHEMICAL WORKS
Flexible Compound Co
Berlend, Wm & Son
Bewe Varnish Co
Lucas, John, Company
Masury, John W., & Son
Perry Austen Company
Pratt & Lambert
SHERWIN WILLIAMS CO
Smith, Edward, & Co
Standard Varnish Works
VALENTINE & COMPANY
Weeks & Co.

DRIFT INDICATOR
SPERRY GYROSCOPE CO.

DRY KILNS
Cutler Dry Kiln Co.
GRAND RAPIDS VENEER WORKS

DYNAMOMETER
Sprague Electric Works

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Allegheny Forging Co.
ALUMINUM CASTINGS CO
Anderson Forge & Machine Co.
BARCALO MFG CO
Burd High Compression Ring Co.
Crosby Steam Gage & Valve Co.
Deliet Theo H., Co
DOEHLER DIE CASTING CO.
ERIE SPECIALTY CO
Fibre Finishing Co.
Gifford, Leland, Co
Gill, P. B., & Sons
Hayes Mfg Co
Hydraulic Pressed Steel Co.
LEVETT WALKER M. CO.
Mel Press Mfg Co
PARK DROP FORGE CO
Pressed & Welded Steel Products Co
Standard Parts Co
STIMPSON EDWIN B., CO.
Taft-Peirce Mfg Co
TIOGA STEEL & IRON CO
Williams, J. H., & Co
WHITMAN & BARNES MFG CO
WYMAN-GORDON CO

ENGINEERING
AUTOMOTIVE ENGINEERING CO
ORDNANCE ENGINEERING CO
WHITE, J G, ENGINEERING CORP

FABRICS
Central Mfg Co.
Hutchinson, Scott Co
Lamb, Finlay & Co
McBratney Robt., & Co.
Whitman, Clarence & Co.

FELT
Advance Felt Specialty & Cutting Co
Booth Felt Co
Western Felt Works

FIRE EXTINGUISHERS
Fyr-Fyter Co
JOHNS-MANVILLE, H W., CO
Pyrene Mfg Co

GAGES
Advance Felt Specialty & Cutting Co.
BOSTON AUTO GAUGE CO.
Crosby Steam Gauge & Valve Co.
FOXBORO CO., INC.
Greenfield Tap & Die Corp.
United States Gage Co

GASKETS
Advance Felt Specialty & Cutting Co
Booth Felt Co
Fibre Finishing Co

GLUE
Armour Glue Works
Baeder & Adamson
Ferdinand L. W., & CO.
WIDMAN, J C., CO

(Continued on page 823)

Aeronautical Trade Directory—*Continued*

GOGGLES

Hardy F A Co
Meyrowitz, E B.
STRAUSS & BUEHLEISEN
Strong Rennard & Nutt
Triplex Safety Glass Corp.
Willson, T. A., & Co., Inc.

HANGARS

American Bridge Co
Anchor Corrugating Construction Co.
Ashley Steel Bldg. Co.
Austin Co. The
Barney, John M.
Bonell Field & Goddard, Inc
Keasby & Mattison
Milliken Brothers
Pruden, The C D., Co.
Steel Fabricating Co., The
Virginia Bridge & Iron Co

HOISTS

YALE & TOWNE MFG CO

LIFE PRESERVERS

Robinson Roders Co.
Universal Safety Mattress Co.

LUMBER

Alcock Co., John L.
American Balsa Corp.
ASTORIA VENEER MILLS & DOCK CO
Chetham Lumber Co
Delgtour, J
Dutton, A. C., Lumber Corp.
Ludlow, Israel
Mengel, C C., & Bros. Co.
New Jersey Veneer Co
Sheip & Vandergrift

LUMINOUS COMPOUND

COLD LIGHT MFG CO.
Cummings, W. L., Chemical Co
RADIUM DIAL CO.
RADIUM LUMINOUS MATERIAL CORP.

MACHINERY, METAL WORKING

DALTON MFG CORP
DEFIANCE MACHINE WORKS
FOX MACHINE CO.
Werner & Swasey Co

MACHINERY, WOOD-WORKING

Curtis Machine Corp
DEFIANCE MACHINE WORKS
FAY, J. A., & EGAN CO
FOX MACHINE CO.
Machinery Merchants, Inc.
MATTISON, C., MACHINE WORKS
Olney & Warrin
PRYIBIL, P., MACHINE CO.
YATES, P. B., MACHINE CO.

MAGNETOS

Berkshire Magneto Corp.
Bosch Magneto Co
ERICSSON MFG CO
Remy Electric Co.
Splitdorf Electrical Co

MANIFOLDS

AJAX AUTO & AERO SHEET METAL CO
Pressed & Welded Steel Products Co.

METALS

Acleral Co of America
AMERICAN BRONZE CORP
American Vanadium Co.
Bethlehem Steel Co.
BETZ-PIERCE CO., THE
BLUM, JULIUS & CO.
Detroit Pressed Steel Co.
Federal Pressed Steel Co.
Garland Ventilator Co
Gueder, Paeschke & Frey Co.
KAWNEER MFG CO
La Salle Steel Co.
LEVETT, WALKER M., CO.
Rumford Metal Co.
SO LUMINUM MFG & ENG CO
Steel Sales Corp.
Standard Alloys Co
STEEL PRODUCTS CO.
STIMPSON, EDWIN B., CO.
Wheeler Frank H & Son

MODEL AIRPLANES

Ideal Aeroplane Supply Co.
Wading River Mfg. Co.

MOTORCYCLES

Excelsior Motor Mfg Supply Co.
HENDEE MFG CO
Harley Davidson Co.
Militaire Motor Vehicle Co. of America

OILS AND LUBRICANTS

Baker Castor Oil Co
Graphite Lubricant Co.
Gulf Refining Co.
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Aeronautical Trade Directory—*Continued*

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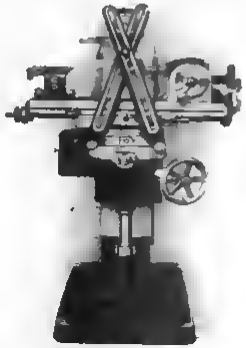
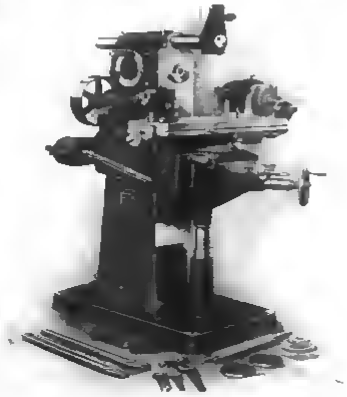


For Rapid Production of Motor Parts

The *demand* for increased production *requires tools* of *great strength* and *durability;* the Fox 2-A Universal Milling Machine illustrated has met this demand, and is being used wherever extreme accuracy and quantity production are required



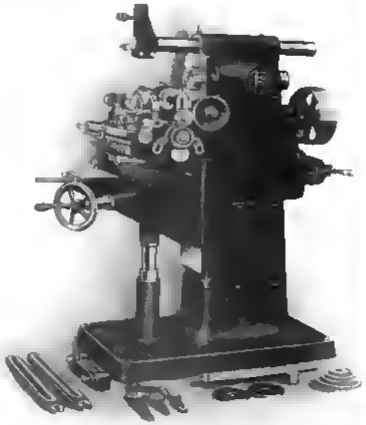
The machine has a universal table, spiral cutting attachment, 10" Dividing Head with 6" Universal Chuck, making it a machine *especially adapted for Tool Room Work*

The *United States Government* is using this machine in its various *repair shops* for *Aeroplane Motors*

You should be using this tool to help the production of parts necessary for the prosecution of the war

SPECIFICATIONS
No. 2-A Miller

Spindle Speeds—12 from 21 to 423 RPM
Table Feeds—6 from .317" to 2.79" per min.
Table—8½ x 27"
Long feed (power) 26"
Vertical feed (hand) 13"
Trans. feed (hand) 8½"
Drive—Single Pulley 10 x 3" running 250 RPM.
Gears—Hardened Steel
Weight—1500 lbs.



We build this same machine with a plain table, omitting the spiral cutting attachment and Dividing Head

Our No. 1 type machine has a four step cone drive, and while being a lighter machine, is a "bear" for work, this is *proven by* the *hundreds* of *them in* the *largest munitions plants*

We also build the Fox Multiple Spindle Drilling Machines

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